Hazard Evaluation for AX-IX, ITS1, 241-SX-401, 241-SX-402, 241-C-801, 241-A-431

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Abstract: Hazards evaluations were performed for 241-AX-IX, ITS-1, SX-401 and 402, the cesium loadout facility (801C), and A431. The results were there is no situation that leads to offsite consequences greater than guidelines and limited situations that may exceed onsite guidelines. Those situations are already addressed by existing accident analyses.

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Revision 1

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

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Hanford Group, Inc.
Richland, Washington
Contractor for the U.S. Department of Energy
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APPENDICES

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TERMS

AB	Authorization Basis
DOE	U.S. Department of Energy
ECN	engineering change notice
FSAR	HNF-SD-WM-SAR-067, *Tank Farms System Final Safety Analysis Report*
HEPA	high-efficiency particulate air (filter)
ITS	In-Tank Solidification
LFL	lower flammability limit
MAR	material at risk
SSC	systems, structures, and components
TSR	Technical Safety Requirements
TWRS	Tank Waste Remediation System
USQ	unreviewed safety question
WIDS	Waste Information Data System

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to identify the hazardous conditions associated with six inactive facilities where Authorization Basis (AB) controls may not be sufficient or may not exist. The facilities are:

- 241-AX Ion Exchanger (AX Tank Farm)
- In-Tank Solidification System (ITS1) (BY Tank Farm)
- 241-SX-401 Condenser Shielding Building (SX Tank Farm)
- 241-SX-402 Condenser Shielding Building (SX Tank Farm)
- 241-C-801 Cesium Loadout Facility (C Tank Farm)
- 241-A-431 Ventilation Building (A Tank Farm).

The hazard evaluation results also will be used to add information to the HNF-SD-WM-SAR-067, *Tank Waste Remediation System Final Safety Analysis Report* (FSAR) database for more complete coverage of tank farm facilities than presently exists.

This document is not intended to authorize any activities within the six facilities; it is only intended to provide information about the hazardous conditions associated with these facilities. The control decision process, as defined in the AB, may be used to determine the adequacy of controls and whether the proposed activity is within the AB. The hazard analysis does not constitute an accident analysis.

There are three primary focuses for the hazard evaluation process:

- Identify the broadest spectrum of potential hazardous conditions.

- Use the collective experience and facility or process understanding to categorize the hazardous conditions as to the frequency and consequences based on the information at hand. As additional information is collected (sometimes at the direction of the hazard evaluation panel), the categorizations may be adjusted. This is often documented in the control decision process.

- Provide a qualitative assessment as to whether the hazardous condition with more significant consequences (e.g., S2 or S3) would likely fall within the envelop of previously hypothesized accidents (Representative Accidents). This aspect of the hazard evaluation process is also checked in the control decision process considering new information or adjustments in the categorizations.

Part of the hazard evaluation process involves a preliminary consideration of possible controls (both TSRs and safety-class or safety-significant systems, structures, and components). The preliminary evaluation of controls assists in determining if activities need to be initiated to develop new controls or perform additional accident analysis.

1.2 BACKGROUND

A 1998 Performance Agreement between the U.S. Department of Energy (DOE) and the contractor stated, "Prepare an Authorization Basis (AB) status on TWRS facilities including a plan for recommended AB modifications by May 1, 1998." As a result, HNF-2503, *Authorization Basis Status Report (Miscellaneous Facilities, Tanks, and Components)*, was prepared. It identified some inadequacies in the AB with a plan to address the inadequacies. Although AB amendments were planned, the DOE directed that an evaluation be performed for an Unreviewed Safety Question (USQ).

USQ TF-98-0785 was issued identifying six facilities that needed additional information included in the AB. Revision 2 of the USQ limited the scope of the inadequacy of the 242-S Evaporator to the "Hot Side" of the facility. Several of the six facilities have had or are having the inadequacies addressed. An amendment to the AB is being filed for the 242-T Evaporator and the 242-S Evaporator. Amendments for 244-AR and 244-CR were implemented in February 2000. The two other facilities in the USQ are ITS1 in the BY Tank Farm and 241-AX-IX.

The AB will be amended for the two evaporators, ITS1, and 241-AX-IX during fiscal year 2002.

In an effort to align facilities with the "right" contractor, the DOE directed that the River Protection Project assume responsibility for several facilities including cribs, inactive miscellaneous underground storage tanks, etc. Four facilities remain to be addressed: 241-A-431, 241-C-801, and 241-SX-401/241-SX-402.

These four facilities have not been accessed for several years. The information contained here is based on design information; historical documentation; interviews with personnel who are familiar with the facility; and observations, both internal and external.

As discussed throughout this report, the knowledge of the contents (e.g., the material at risk) and condition (e.g., isolation status) is limited. This hazard evaluation and subsequent control decision process relied heavily on engineering judgment and the expertise of the involved individuals. That engineering judgment weighed heavily in the assessment of the risk posed by the facilities relative to other tank farm facilities and relative to DOE guidance. In addition engineering and management decisions were made as to the expenditure of resources with respect to the acquisition of additional data to reinforce the confidence in the facility risk. To move to the next level of confidence would likely involve use of sophisticated equipment (e.g., leak testing for isolation or radiography for component integrity or contents), field work to cut open systems for characterization, and/or excavations for verification of isolation. These types of activities will be funded and done as part of the decontamination and decommissioning of the facilities in any case. The judgment is that use of such resources at this stage is not warranted. However, such activity can be directed if warranted and justified.

The facilities are inactive. The condition of the facilities is, in general, deteriorating. There are no immediate plans for maintenance or transitioning to decontamination and decommissioning. The hazards presented by the facilities are limited by the fact that there is not a source of energy within the facility to initiate an accident. However, natural phenomena and aging/degrading structures do present a concern. Based on radiation surveys of accessible areas, it appears the material at risk (MAR) is limited to residual contamination.

These facilities will be classified as nuclear facilities. It may be possible with the detailed analysis to demonstrate that one or more could be classified as radiological facilities based on the quantities of radionuclides contained within them. Depending on the specific radionuclide and the concentration, some estimates are that it would require less than between 1 to 10 gal of waste to allow a facility to be categorized as radiological. The MAR is most likely at the low end of the inventory for hazard Category 3. Because of the uncertainty of specific material in the facilities and the resources that would be required to provide the rationale for the classification, the decision was made to go to a conservative position of classifying them as nuclear.

1.3 CHANGES IN REVISION 1

Because there was a significant lapse of time between the release of Revision 0 of this document and the submittal of the amendment that it supports, it is appropriate that it be reviewed and revised as necessary. The following summarizes the changes made in Revision 1:

- Review the process and results of the hazard evaluation against contemporary procedures and benchmarks to ensure consistency.
- Provide more detailed/expanded information.
- Update information based on specific comments.
- General editorial review; particularly in view of the release of a desk instruction with specific standards.

While changes were made to some parts (e.g., remarks or initiating event) of the hazardous conditions listed in Appendix B, changes were not made to the frequency or consequences. Because this is a historical document that captures the judgment and conclusions of a particular group of experienced individuals at a particular time, it would be inappropriate to change their determination in this document. In the case of the hazardous conditions identified for these six facilities, new information was collected subsequent to the hazard evaluation. This information was considered in the formal control decision process, which again consisted of a panel of experienced individuals. Additional information that affected the final hazardous condition frequency and consequence came from reviewers of the process and from individuals involved in parallel processes. In some cases changes were made to maintain a consistent approach with other activities. All this information is captured in the change memo that accompanies each hazardous condition in the database.

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2.0 DESCRIPTION

This section describes each of the six facilities. There is some common information.

HNF-2503 was written in response to a request from the DOE to, among other things, consider, "...the determination of its (the AB's) adequacy with respect to...comprehensive hazards identification..." In response, the contractor noted, "Hazards are identified and discussed throughout Chapters 3, 4, and 5 and in Appendices A and B." 241-AX-IX is described in Section 3.3.5. ITS1 is described in Section 3.3.15. The 241-SX-401 Condenser Shielding Building, 241-SX-402 Condenser Shielding Building, 241-C-801 Cesium Loadout Facility, and 241-A-431 Ventilation Building are not included in HNF-2503 because they were not in the control of River Protection Project at the time the document was written. There is no other current hazard evaluation for the facilities.

There is no occurrence report related to 241-AX-IX, ITS1, 241-C-801, 241-A-431, or 241-SX-402 in the FSAR listing of occurrences (Appendix B). 241-A-431 shutdown took place in 1969. 241-C-801 and 241-AX-IX were shut down in 1976. The FSAR listing of occurrences was initiated in 1972. One occurrence related to 241-SX-401 is listed in Appendix B of the FSAR. On October 14, 1975, Occurrence Number 75-119 was generated because the radionuclides in the condensate cooling water exceeded specifications. The cause was suspected to be a failed condenser in 241-SX-401.

None of these facilities have a current fire hazard analysis or a current structural analysis.

Some general comments can be made about the facilities. Exceptions and expansions will be provided in the applicable sections.

- The facilities do not present a criticality concern. In every case, the potential for fissile material in any appreciable quantity is extremely unlikely. Four of the six facilities processed vapors from tanks. The other two (241-AX-IX and 241-C-801) were basically "flow-through" facilities. The only tanks (condensate seal tanks and condensate return head tanks in the Condenser Shielding Buildings, the ion exchangers in 241-AX-IX and ITS1, miscellaneous tanks in ITS1) by design did not contain fissile material. Other components (de-entrainers, filters, condensers) may have contamination, but not significant quantities of waste containing fissile materials.

- Organic complexants do not present a hazard in these facilities. As noted in the criticality discussion, the components (e.g., tanks, condensers, de-entrainers) are not large, did not store waste, and generally did not contain liquids.

- Flammable gas concerns may be present albeit in a limited scope.

- Potential misrouting of waste to any of the facilities is discussed in the specific facility descriptions.

- None of the facilities is addressed in the flammable gas USQ.

- Each of the facilities is largely above grade. Construction approaches varied. Three (241-SX-401, 241-SX-402, and 241-A-431) are reinforced concrete structures. One (241-C-801) is a metal structure above grade. Two (ITS1 and 241-AX-IX) have no building.

- The MAR for each facility consists largely of loose contamination on the floor, walls, components, and ceiling; internal contamination of pipes, condensers, and de-entrainers; and/or waste captured in filters or ion exchange resin. This comment is based on radiation surveys of accessible components as well as design features.

- By design and operation, the potential for tank waste in the facilities is limited. The largest potential quantities are in the pipes embedded in the concrete in the Cesium Loadout Facility if it was not flushed upon shutdown, and in the resin column of 241-AX-IX. These quantities are more than likely bounded by the quantities assumed in the aboveground tank failure due to excessive dome loading accident.

- By design and operation, the amount of liquid in each facility is limited. The bulk of liquid in 241-AX-IX and ITS1 is contained in the ion exchange column and filter. Liquid in the Cesium Loadout Facility is limited to that in the pipes. There is no liquid in 241-A-431. There is probably no liquid in 241-SX-402 because it was not operated. The liquid in 241-SX-401 is limited to that in the condensate head return tank and the condensate seal tank. Any liquid in these tanks would have likely evaporated during the more than 25 years since the facility has been out of service and condensed in the cool underground pipe to the crib. This evaporation would have likely taken place in any liquid-containing component in most of the facilities.

- All the facilities are vulnerable to natural phenomena to some extent. They are above-grade with structures that were not designed to present-day standards and have not been maintained.

- Steam is not supplied to any of the facilities, nor is there any raw water. It is unlikely that there is electrical power to some of the facilities; however, electrical isolation could not be verified for all facilities. There is no compressed gas being supplied to any facility.

2.1 241-AX-IX ION EXCHANGER (AX TANK FARM)

The facility was installed between AX and A Tank Farms in 1967-1969 as a prototypical cesium removal system. The concept was to remove the cesium from the vapor condensate from the aging waste tank farms using ion exchange. The ion exchange column was operated from 1973 until 1976. In the late 1990s, a series of Engineering Change Notices were undertaken to isolate the facility from the tank farms. For example, ECN 636354, *Suppl ECN to Mod Engineering Flow Diagram to Correspond with Field Changes per ECN 611271 & Depict Isolation of 241-AX Ion Exchange Column*, cut and capped the supply and discharge lines.

2.1.1 Facility Description/Operation

The facility consists of an ion exchange column in a shielded structure; a filter, valves, and piping; and a radiation detector. The facility does not include tank 241-A-417, nor the pumps and valves directly associated with that tank. The facility has been isolated from the tank.

Besides the piping, valves, and instruments, there are two major components: the filter and the ion exchanger. The system is made of carbon steel components and pipe.

The filter housing is approximately 20 ft^3. There is no radiation posting at the filter indicating elevated radiation fields.

The ion exchanger is contained within what is basically a vertical, shielded pipe. The outside is a culvert pipe with an inside diameter of 6.5 ft. A reinforced concrete pipe with an inside diameter of 5 ft is inserted in the culvert pipe. The annular gap between the concrete pipe and the culvert is filled with concrete. This provides an effective 8 in. of concrete shielding. This shield is 12 ft high. It rests on a pad that is 8.2 ft high. The base is 6.7 ft square on the outside with an internal cavity that is 5.2 ft square to provide a chase for pipes to enter the shielded pipe and provide access to empty the ion exchanger.

The ion exchanger is 11.5 ft tall and 2 ft in diameter. Its volume is 270 gal. If one considers only the ion exchange column height (9.5 ft), the volume is 224 gal. The resin used was zeolite or Zeolon 900, a synthetic, particle-size-controlled version of zeolite. It is a crystalline aluminosilicate material (SiO_2/Al_3O_2).

Boiling was initiated in the aging waste tanks by the introduction of steam. Once the boiling was initiated, the waste would continue releasing moist vapor into the headspace. These vapors were drawn off, collected, and processed. The processing including de-entrainment, condensing, filtering, etc. When the vapor flowed through condensers, condensibles would collect and be routed to further removal of radioactive material, sampling, and discharge to a crib or pond. In the case of the aging waste tanks, the vapors were routed through 241-A-401 just to the southeast of 241-AX-IX and the condensation collected in 241-A-417 just to the southwest of 241-AX-IX.

Using either pump 417-1 or 417-2, condensate could be pumped from the tank at 65 gal/min with 150 ft of developed head. Through valving in the pump pit, liquid could be routed back to the waste tanks or to the ion exchanger. This 2-in. line has been capped. The tank liquid normally would go through a filter, although it could be bypassed. Then the liquid entered the shielded area and was piped to the top of the ion exchanger. It flowed down through the ion exchanger, out the bottom, and then to a radiation detector, before draining to the tank 241-A-417 tank overflow crib (216-A-08). The liquid could be re-routed back to tank 241-A-417 through riser 12. There were various means of bypassing components for repair or calibration. There were also various sample points.

Resin could be added through a funnel at the top. A resin screen at the bottom supported the resin and one at the top precluded inadvertent misrouting of resin during regeneration or backwashing. Resin could be regenerated and the eluent sampled. The ion exchanger could function for months before it would become loaded and cesium would start to break through. This would be detected by increasing radiation levels in the effluent. A regeneration process was followed in which two 1,000-gal batches of $NaNO_3$ solution would be trucked to the column and the solution flushed through the column to one of the underground storage tanks. The regeneration would be followed by a rinse with raw water obtained from a hose station. The filter also could be backflushed with raw water.

The resin in the ion exchanger was zeolite or a similar, synthetic resin. Memo 97-026, *East Tank Farms Facility Chemical Vulnerability Study*, states "From a chemical reactivity standpoint, the resin used in 241-AX Ion Exchange Column does not pose a safety hazard."

Several naturally occurring and synthetic minerals exhibit a high cation exchange capacity, and specifically for strontium and cesium. Zeolite is one of the better-known resins. These are hydrated, crystalline aluminosilicates. The zeolites have a relatively open three-dimensional framework structure with channels and interconnecting cavities. Specificity and exchange capacity are determined by the SiO_2/Al_2O_3 ratio and by the crystalline structure. A low ratio increases the exchange capacity, while a high ratio provides greater acid stability.

Synthetic zeolites are prepared by gelling sodium silicate, sodium aluminate, and sodium hydroxide in fixed ratios followed by digestion to permit crystallization to 0.1 to 10 micron particle size. After mixing with a clay binder, it is extruded, dried, and rotary-kiln fired.

There was no steam to the facility. Electrical power was used for a heater at the bottom of the column. It has not been physically disconnected, but no current is flowing to the heater.

2.1.2 Material at Risk

The contents of the ion exchanger are not known. It is not known if there is liquid in it, or if the column was eluted at the time of its shutdown. 241-AX-IX was used to treat condensate from vapor from the aging waste tanks. No process history could be found to determine the constituents of any remaining waste material. Radiation readings were taken over the top of the shield wall in late August 2000. Indicating essentially background, they support the hypothesis that the radioactive material in the column is limited.

The amount of radioactive material on the filter is not known, or even if there is a filter in the housing.

2.2 IN-TANK SOLIDIFICATION SYSTEM (BY TANK FARM)

There were two ITS Systems constructed in the BY Tank Farm in the 1950s. The first, ITS1, used 241-BY-102 as its "feed tank" and circulated hot air through the tank to evaporate the waste. ITS1 started operating on March 19, 1965, and operated until June 30, 1974. The hot air supply components have been removed. Major components of the vapor processing system remain set up on the farm. The aboveground components were used to process the heated vapor from the tank. This facility is the subject of the following discussion.

ITS2 used electric heaters to evaporate waste in its "feed tank," 241-BY-112. Conceptually 3200 kW immersion heaters would boil off 20 gal/min. ITS2 started operating on February 18, 1968, and operated until June 30, 1974. Except for two underground tanks, it has been dismantled. Those two tanks (241-ITS2-TK1, a condenser located in a pit above 241-BY-112, and 241-ITS2-TK2, a flush tank located at the south edge of 241-BY-112) have been classified as inactive miscellaneous underground storage tanks and are adequately addressed in the FSAR. The flush tank was used to flush off waste adhering to the immersion heater. ITS2 shared the ion exchanger with ITS1 during operation.

2.2.1 Facility Description/Operation

The hazard evaluation assumed that the ITS-1 consisted of the following components:

- De-Entrainment Vessel, 241-BY-ITS1-DM-102, basically a vertical tank 19 ft tall by 11 ft in diameter
- Condenser, 241-BY-ITS1-EX-1, 14 ft long by 2 ft 3 in. in diameter
- Demister, 241-ITS1-DM-1
- Cyclone separator (same equipment identification as the demister)
- High-efficiency particulate air (HEPA) filter and exhaust system
- Feed tank (condensate catch tank), 241-ITS1-TK-2, vertical tank 5 ft high by 5 ft 6 in. in diameter, nominal capacity of 400 gal
- Filter, 241-ITS1-IX-2, 2.1 ft in diameter by 4.5 ft tall
- Ion exchange column, 241-ITS1-IX-1, 18 in. by 9 ft tall
- Solution holdup tank, an oval tank with the major axis 3 ft 6 in. and the minor axis 1 ft 8 in. and 2 ft high.

The ion exchange column contained zeolite resin. This type of resin is described in Section 2.1. Shielding around the ion exchange column consists of a concrete pipe approximately 15 ft high. The ion exchanger is elevated approximately 5 ft to form a pipe chase for pipes connecting to the ion exchanger. The design of the shielding is to reduce the dose from up to 20 Ci of ^{137}Cs to less than 30 mR/h.

Sample points, sight glasses, and instrumentation taps were provided in various locations.

Hot air was forced into 241-BY-102 through a circulator assembly causing the waste to boil. The filtered air was compressed and then heated. It was routed through a 10-in. aboveground duct to a pump riser near the center of the tank and down into the circulator assembly.

The vapor from the waste was drawn through a riser at the northwest edge of the tank to a 20-in. aboveground duct to the de-entrainer. The vapor then passed through the condenser. Condensate drained to the filter and then to the ion exchanger. The filtered and polished condensate then drained to tank 216-BY-201 (supernatant disposal flush tank north of BY Tank

Farm) and finally to crib 216-BY-5. Tank 216-BY-201 is an inactive miscellaneous underground storage tank and is isolated.

Raw water was supplied to the condenser. The heated raw water was routed to the 207-B basin south of the B Tank Farm. The 207-B Basin is now dry.

Non-condensible vapors from the condenser passed through the York demister, through the cyclone separator, to the HEPA filters, and out the exhauster.

Liquid from the demister could be drained to the crib through a radiation monitor. The filter also could be drained through the same line (which was the same as the ion exchanger outlet). The demister also could be diverted back to tank 241-BY-102 if the liquid was not being processed through the filter/ion exchanger and could not be discharged to the crib.

Raw water could be used to backflush the ion exchanger through a hose station. The backflush line was the same line as the eluent line used for regeneration. Eluent/backflush liquid and the drain from the shielding enclosure all returned to tank 241-BY-102. There is a resin fill connection at the top of the ion exchanger as well as a resin removal connection at the bottom.

ITS1 has been effectively isolated from the tank farm. The 20-in. ducting has been removed, other piping to the tanks also has been disconnected and capped. The BY Tank Farm is clean, controlled, and stable. That means there is no electrical power to pumps and fans that remain in ITS1. Raw water has been isolated to the tank farm, although the raw water line to ITS1 has not been physically disconnected from the header. There is no potable water or compressed gas to the tank farm. The compressed air line is not disconnected from ITS1.

The shutdown plan called for draining all liquids and ion exchange resin to underground tank 241-BY-102. By design, liquid would not be retained in the de-entrainer, condenser, demister, cyclone separator, HEPA filters, or exhauster. Small amounts of liquid may remain in the condensate catch tank, filter, ion exchanger, and associated piping. Draining has not been verified.

Passive ventilation is provided through the ITS1 HEPA filters.

(Note that subsequent field walkdown could find no trace of the tank.)

There was a solution holdup tank in a pit at the north edge of tank 241-BY-101. An agitator and a 3 kW heater were installed in the tank. The solution holdup tank had ten piping connections:

- Three lines are for instruments.
- Two lines are raw water to and from a cooler (raw water is isolated from the tank contents).
- A raw water connection exists, probably for flushing or water addition to the solution.
- The tank overflow could be routed either to tank 241-BY-102 or to the crib.

- The pump discharge was normally routed to one of three lines in the de-entrainment tank (at three different elevations) or the tank could be pumped to the crib, or back to tank 241-BY-102.
- The solution could be recirculated from the solution holdup tank, through the pump, into the top of the de-entrainer, and drain out the bottom of the de-entrainer back to the solution holdup tank.
- An equalizing vent line was the last line with an orifice between the de-entrainer and the solution holdup tank.

Solids could be added to the tank through a funnel. The pit has a sump that had a 5 gal/min jet pump powered by raw water. The pump discharge was routed to tank 241-BY-102. Of all the lines, the only one that connected to a waste tank is the overflow/pump-out line (the last mentioned line). A visual inspection of the solution holdup tank pit in August 2000 revealed that it has been isolated and weather sealed. The solution lines to the de-entrainer have been removed.

Misrouting is not credible because:

- The tank farm is clean, controlled, and stable; i.e., there is no power on the farm to pump waste to ITS1.
- The tanks have been interim stabilized; i.e., the pumpable liquid has been removed.
- Much of the interconnecting piping has been removed.

Gas could come from tank 241-BY-102 into ITS1 through a riser. Calculations in RPP-5926, *Steady-State Flammable Gas Release Rate Calculation and Lower Flammability Level Evaluation for Hanford Tank Waste*, demonstrate that, even if there is only barometric breathing in the feed tank (241-BY-102), the flammable gas concentration in the tank headspaces would not reach the lower flammability limit (LFL).

2.2.2 Material at Risk

Characterization of wastes in ITS1 has not been performed. Expected radionuclides are those representative of tank 241-BY-102 contents from offgas and condensate carryover. Dose rates around the catch tank, resin column, and filter allow unrestricted access; a high radiation area is posted around the de-entrainer. The ion exchanger was designed so the nominal capacity for ^{137}Cs was 20 Ci. The shielding was designed to maintain the dose rate at less than 20 mR/h.

ITS1 is different from other facilities in that asbestos lagging on the demister tank is exposed to the environment.

2.3 241-SX-401 AND 241-SX-402, CONDENSER SHIELDING BUILDINGS (SX TANK FARM)

The Condenser Shielding Buildings (241-SX-401 and 241-SX-402) were built in 1954. 241-SX-401 was used as designed to cool some of the tanks in the SX Tank Farm by cooling the vapor from the tank headspace. This continued until 1975 when the facility's use was ended.

241-SX-402 was designed and constructed to be redundant to 241-SX-401. It was used very little, and the contamination levels are significantly less than those of 241-SX-401. There is no report as to how the facilities were left when they were shut down (purged, flushed, etc.)

Conceptually, the system worked by decreasing the headspace pressure in tank 241-SX-106 by drawing the vapor through the 24-in. vapor header. Five other tanks (241-SX-101 through 241-SX-105) are manifolded to the vapor space of 241-SX-106. As the vapor pressure in tank 241-SX-106 was lowered and/or the vapor pressure in the other tanks increased because of increased steaming, the vapor from those tanks flowed to 241-SX-106.

2.3.1 Facility Description/Operation

Each facility also was referred to as the Waste Disposal Condenser House or the Condenser Shielding Building. Each facility consists of three components: the Condenser Shielding Building proper, the attached Control Building, and a dry well, all located within the SX Tank Farm. The Condenser Shielding Building is 36 ft along its north-south axis. It is 24 ft wide and 24.5 ft high. The building is 7 ft below grade and 17.5 ft above grade. The building is constructed of reinforced concrete. The walls are 2.5 ft thick and the ceiling is 1 ft thick.

Personnel enter at floor level through the access door at the south end of the building. The stairway from grade level to the operating floor is outside.

A buried 24-in. diameter vapor header runs from a manhole by tank 241-SX-106 to the Condenser Shielding Buildings. En route, it is teed, with one line going to 241-SX-401 and the other branch going though an isolation valve to 241-SX-402. The isolation valve is directly north of 241-SX-402.

The condenser's 24-in. shells received and cooled the vapor from the 24-in. header from tank 241-SX-106, thereby the condensibles were condensed. Four 12-in. tees from the vapor header are valved to the lower four condensers (numbers 1 through 4). Vapor that was not condensed in the lower condenser(s) flowed to the upper condenser(s) (numbers 5 and 6) through the 6-in. vent header. Non-condensible gases from the upper condensers were vented from the condensers to the north through dedicated 4-in. vents with filters. See the following discussion concerning ventilation.

North of the 241-SX-401 and 241-SX-402 condenser shielding buildings is a sampler pit that is approximately 3 ft by 3.7 ft and 3 ft 6 in. deep. A sample line runs from the condensate seal tank through the wall belowgrade to the pit. In the pit is a small 3-in. high stainless steel sample tank and some valves.

The condenser tubes contained raw/cooling water that removed the latent heat of the condensible vapors. Raw water was provided from an 8-in. header on the east side of the building. As used cooling water, it was discharged to "the swamp," an area west of Cooper Avenue and north of 13th Street. The discharge of the 8-in. cooling water was 1,154 ft away from the building with an 18-in. change in elevation.

Next to (west of) the sampler pit is an instrument pit 4 by 7.9 ft covered by 22-gauge sheet metal. Included was access to flow indicators for the cooling water flowing to the swamp and temperature of the condensate return head tank. The pit has access to an opening in the north wall of the building that is 4.3 ft square.

A condensate line drained from each of the condensers to a header leading to the condensate seal tank at the north end of the building. The condensate seal tank could be sampled from the sample pit outside the building to the north. The condensate seal tank cascaded to the condensate return head tank also at the north end of the building. If the condensate were unacceptable for discharge, the condensate return head tank could be drained via one of two 3-in. lines back to tank 241-SX-106 (from 241-SX-401) or tank 241-SX-112 (from 241-SX-402). The lines for the former were routed through the valve and sampler pit. For 241-SX-402, the lines were routed through the condensate valve pit. Normally the condensate was acceptable for discharge and the condensate return head tank overflow was routed to the 216-S-21 Crib, which was 670 ft to the northwest through an 8-in. line. There is approximately a 3-ft elevation drop under which the gravity system operates.

Vapor from the condensate seal tank and the condensate return head tank equilibrated with the condensers via a 12-in. vent header. As previously noted, non-condensibles were vented from the upper condenser(s) through 4-in. headers to vent filters outside the north wall of the building.

The following vessels are part of each facility:

- Six condensers 12.2 ft long including the dished ends; 24-in. diameter shells; 280 gal including tubes
- Condensate return head tank 11.3 ft tall including dished caps; 24 in. outside diameter; 1/2-in. wall thickness; volume = 240 gal; operating point = 62 percent = 148 gal
- Condensate seal tank 11.3 ft tall including dished caps; 24 in. outside diameter; 1/2-in. wall thickness; 7.2 ft to overflow including dished bottom head; volume = 240 gal; operating point = 63 percent = 150 gal; tank can be drained.

Each facility has eight lines entering/leaving:

- The 24-in. vapor header from tank 241-SX-106
- Raw water for cooling
- Cooling water to the swamp
- Condensate overflow to the crib

- Two condensate returns to tank 241-SX-106 (for 241-SX-401) and tank 241-SX-112 (for 241-SX-402)
- Sample line and the isolated drain line from the condensate seal tank.

One of the upper condensers for each facility has its vent line isolated at the wall. The other condenser for 241-SX-401 has its vent line capped outside. For 241-SX-402, the original vent is in place.

Each of the lower condensers has five isolation valves. Four can be operated from outside the west wall by the use of handwheels. The fifth valve can be operated from outside the east wall. Each of the upper condensers has four isolation valves. Three can be operated from outside the east wall and one from outside the west wall. Three other valves also can be operated from outside the building.

To the east of the building is a valve pit for raw water supply that is approximately 6 by 3 ft.

Attached to the south end of the building is a 12- by 8-ft wood and plaster board control room. The building has degraded and has openings to the environment. There is no process line in the room.

2.3.1.1 241-SX-401 Waste Disposal Condenser House or Condenser Shielding Building. 241-SX-401 is west of tank 241-SX-106.

The vapor header connecting tank 241-SX-106 to 241-SX-401 is noted on Drawing H-2-73223, *Piping Waste Tank Isolation 241 SX 106*, as "TO BE ISOLATED AT CONDENSER BUILDING." There is no common isolation point in the line and there is no record that a blank or some other type of physical isolation was performed. The intention of the note was probably to indicate that the isolation valves to the individual condensers were to be closed.

The two condensate lines are connected to a manifold that allowed routing the condensate to tank 241-SX-101 through tank 241-SX-106. The loop line for each of the other five tanks has been cut and capped so that the only connection is with tank 241-SX-106. A field note on the drawing states, "THE SIX (6) VALVES WILL NOT MOVE DUE TO CORROSION. LEAVE VALVES AS THEY ARE AND REMOVE VALVE HANDWHEELS." There is no pitch shown on the drawings for the two condensate lines, so it is unclear whether those lines have drained. There are other potential pockets of condensate in the lines.

The dry well is fed from a drain line from the condensate sampler pit on the north side of the Condenser Shielding Building. The line to the dry well also has a tee to a manual isolation valve in a line to drain the condensate seal tank. A second line to the dry well is from the tank 241-SX-106 valve and sampler pit and condensate pump pit. Drawings indicate that the drain line in each pit is plugged. It would drain leakage, flush water, or snowmelt and rainwater intrusion to the dry well. The dry well is a 4-ft diameter pipe that is 15 ft long extending down from the ground surface. The bottom third is filled with gravel. The dry well is 38 ft to the east of the sampler pit. It is covered with a wood cover and has handrails around it with radiation signs posted. The dry well is not now included in the FSAR, but is considered part of the facility. The AB amendment that results from this evaluation process will include the dry well.

An air compressor with a receiver tank was used to provide purge air to the vapor header and was directed to selected condenser(s) through isolation valves.

Drawing H-2-33544, *Condenser Vent System General Arrgt Bldg 401*, shows two fans with filters with a stack on the north side of the 241-SX-401 Condenser Shielding Building. One of the two vent lines (the west one) for each of the facilities is capped, and appears to have not been used. Extending down the wall of 241-SX-401 from the east vent line is a duct that is sealed. It appears that a ventilation system may have been in place, and was removed.

The similar vent line for 241-SX-402 has the vent filter arrangement installed in accordance with drawings.

There is no active ventilation of the buildings.

2.3.1.2 241-SX-402 Waste Disposal Condenser House or Condenser Shielding Building. A facility description of 241-SX-402 will not repeat that of 241-SX-401. Only the differences will be identified. 241-SX-402 is south of 241-SX-401 and west of tank 241-SX-109.

The two condensate lines from the building to tank 241-SX-112 have been isolated in the tank's condensate valve pit. The air compressor has been removed. There are some additional instruments on the system.

The dry well for 241-SX-402 is directly east of the building.

Although the leak tightness of the valve has not been verified, the vapor header isolation valve to 241-SX-402 has been visually verified as being closed.

2.3.2 Material at Risk

The contents of the various components within the facility are not well defined. Inventories at risk can be estimated based on individual component volumes and historical data on material that came into the facility. Waste was not stored in the buildings. There is contamination from spills and/or leaks. Radiation levels in 241-SX-401 are reasonable, considering the type of material that was condensed. There is no high radiation area, although one area near the condensate seal tank approaches the limit. A hot spot of approximately 1 R/h exists at the bottom of one of the tanks.

Radiation levels are essentially background in 241-SX-402, indicating no radiological inventory.

There was no chemical processing within the facility. There are no chemicals stored within either building. Therefore, there is no chemical inventory to present a toxicological hazard with respect to the safety analysis.

2.3.3 Facility-Specific Concerns

As noted in the general discussion above, there is no applicable fire hazard analysis for 241-SX-401 or 241-SX-402. Tank 241-SX-106 (as well as other tanks that vent through it) has been classified as having the potential for generating flammable gas. To control the possibility of high flammable gas concentrations, tank 241-SX-106 and the associated tanks have active ventilation and the headspaces are monitored. The concentration has remained low. There are then some possible scenarios that need to be addressed for the facility:

- Is the piping configured such that flammable gas may accumulate in the facility? If there is no restriction in the piping, the SX tank active ventilation will continue to cause the appendages to equilibrate with the bulk headspace through a Venturi effect, and the result of barometric breathing and molecular diffusion.

- Is the piping configured such that there is isolation between the tank and the facility (either isolation valves or loop seals)? This isolation creates a problem in one of two situations: gas generation in the facility and/or isolation when the concentration happened to be high. With respect to the first possibility, it is extremely unlikely that there is any appreciable amount of waste in the building because of the piping configuration and design. Therefore, any gas generation would have to be from undrained condensate. The maximum amount of condensate in the condensate seal tank and condensate return head tank is 300 gal.

- With respect to the possibility of component isolation with high concentrations of flammable gas captured, it is unlikely, although it cannot be disproved. The components were vented to the atmosphere, and there was a purge methodology available for use upon shutdown (although there is no record it was used).

Calculations in RPP-5926 demonstrate that, even if there is only barometric breathing in the six tanks (241-SX-101 through 242-SX-106), the flammable gas concentration in the tank headspaces would not reach the LFL. Therefore, the likelihood of flammable gas in concentrations above the LFL collecting in 241-SX-401 is extremely unlikely (i.e., $\leq 10^{-4}$ to 10^{-6}).

While the vapor header may present a path for vapors from 241-SX-106 to the Condenser Shielding Building, that gives rise to a flammable gas concern (as discussed above) and not a waste misrouting event. The only connection between the waste tank and the facility is the potential operation of a condensate pump in tank 241-SX-106 to the condensate seal tank, which would overflow to the crib. The pump is in a weather-sealed pit without power, and the valve lineup to pump from tank 241-SX-106 to the condensate seal tank is contrary to operating practice.

2.4 241-C-801 CESIUM LOADOUT FACILITY (C TANK FARM)

The Cesium Loadout Facility in the C Tank Farm is inactive. It was constructed in 1962, commenced operation that year, and operated until 1976. By providing cesium-processing facilities, it freed the Plutonium-Uranium Extraction Plant to be devoted to other programs. During those years, it was basically a transfer facility. Cesium-rich waste was removed from tank 241-C-103 to a cask in the facility. The cesium was removed from the waste, and the cesium-depleted waste was returned from the cask to tank 241-C-102.

2.4.1 Facility Description/Operation

The Cesium Loadout Facility consists of three components: the facility proper, and two dry wells. The Cesium Loadout Building is a 32- by 26- by 28-ft pre-engineered building in the east side of the C Tank Farm. The lower 8.5 ft of the loadout room and 7 ft of the operating room are reinforced concrete. The southwest side of the building that is concrete (the operating room and valve pit room) is below grade, while the northeast side of the building is exposed. The upper 12 ft of the building are metal. The long axis of the building is rotated 45 degrees from a north-south orientation.

The building consists of three sections: the operating room, the valve pit room, and the loadout room. Each section is accessed separately, and discussed below.

A 5-ton crane bridges the loadout room and valve pit room, with its rails running along the southwest and northeast walls.

There are basically 14 lines connecting the building to external facilities and processes. (One line leaves the building and tees into two lines.) There are two lines, as noted below, that go to the first dry well. One line goes to the second dry well. A 1-in. air line, a 1-in. steam line for a jet pump in the valve pit and two unit heaters, and a 1½-in. raw water line provide services to the building. These three lines are isolated.

A 2-in. line supplies raw water to a cooler at the top of the feed tank (241-C-103). There are four additional 3/8-in. lines. Two of the four lines are raw water lines from the raw water supply in the building to the pump at tank 241-C-103. Raw water would be used to pre-lube the pump through a timer that opened a raw water valve three minutes before pump start and closed it three to five minutes after pump start. The other two lines are instrument air lines to the tank and cooler for purging and level measurement in the cooler. A note is included on Drawing H-2-73343, *Piping Waste Tank Isolation TK 241 C 103,* to isolate the lines in the Loadout Building. It says, "ISOLATE (4) 3/8 M32, 1" AND 2" LINES INSIDE 241-C-801 LOADOUT BLDG. DISCONNECT AND CUT 3/8" LINES AT WALL. SEAL WALL PENETRATION W/RTV SEALANT. REMOVE ASSOCIATED VALVES ON 2" RW LINE & INSTALL BLIND FLANGES PER DETAIL 1, H-2-73450. REMOVE TEE AND VALVE FROM 1" AIR LINE..." Another note on the drawing near the pump pit says, "REMOVE J-BOX FROM SIDE OF PIT WALL. CUT ELECT CND BELOW GRADE."

The two major lines (one tees into two) are the process lines that connect the building to the C Tank Farm. One 1½-in. line comes from a pump/cooler in a riser pit for tank 241-C-103. The pump is in riser 09 in pit 241-CR-03A. The return line from the building is a 3-in. line that exits the building and goes to a three-way valve (Jamesbury Valve*) at tank 241-C-103. One 3-in. line returns to tank 241-C-103 and the same riser pit but is connected to riser 5. The other route from the three-way valve is to riser 2 in tank 241-C-102.

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*Jamesbury Valve is a trademark of Jamesbury Inc.

The pump suction was 4.5 ft from the bottom of the feed tank. A total of 10 gal/min was delivered at a 30-ft head to the cooler in the top of the tank. Waste was cooled by the raw water in the tubes, and left the cooler through a screened intake pipe. The waste flowed below grade to the valve pit where it was basically routed directly to a cask in the loadout room.

The first dry well is a standard dry well located approximately 100 ft northeast of the building. It is just outside the tank farm fence. Two floor drains are routed to the dry well: a 2-in. line from the valve pit and a 3-in. drain from the loadout ramp area. This dry well is considered part of the facility.

The second dry well received condensate from the steam to the building. Three steam traps are routed to a 1-in. line to the dry well. The standard dry well is located just to the northeast of the middle of the building. This dry well is considered part of the facility.

2.4.1.1 Loadout Room. The loadout room occupies the length of the building on the northeast side and is 15.5 ft wide and 20 ft high. The wall between the loadout room and the other parts of the building is 1½ ft thick concrete for most of the length. In the southeast wall is a 12-ft wide vehicle access door, and around the corner in the northeast wall is a personnel door. A 733 kW (215,000 Btu/h) unit heater is in the room.

A stairway is installed on the inboard wall from grade level to a catwalk approximately 7 ft high. This allowed access to the top of the cask.

At the far end of the catwalk there is an opening in the wall between the loadout room and the valve pit room that is approximately 4 ft wide.

The cask (HAPO IV) was brought into the room on a truck trailer. It contained Delcalso resin. Delcalso is a non-zeolite resin, an amorphous alumininosilicate gel produced by Ionac Chemical Company. Unlike the zeolites, water forms an integral part of the Decalso structure. The cesium that was removed was transferred to Oak Ridge.

2.4.1.2 Valve Pit Room. The valve pit room is 8 by 15 ft. From the valve pit cover it is 12 ft high. It is located behind the operating room (to the northwest). It is accessible by a personnel door in the southwest wall and from the loadout room through the above-mentioned opening. At grade level, operators enter at the top of the cover block over the valve pit. The interior dimensions of the valve pit are 4 by 6 by 2.25 ft. The valve pit cover is reinforced concrete 1.5 ft thick, and can only be removed by the crane.

In the valve pit, a 5 gal/min raw water spray nozzle was installed in each corner of the room, apparently for washing down the pit. Approximately ten valves, a water jet pump, and a steam jet pump are in the pit. The floor drain and an overflow are routed through a common line to the dry well. The floor is pitched to the floor low point drain. Three 2 in., 3-way connectors are in place in the southwest wall (the outside wall toward the tank farm), including one spare. One of the connectors was used for routing the waste into the facility, and a second routed it to the outgoing line through the 5 gal/min steam jet pump. A third line came from the cask to the valve pit where there is a 10 gal/min raw water jet pump. This line is identified as "Decalso M. T. Out", and could be used to transfer spent ion exchange resin from the cask to the underground storage tank. Piping between the valve pit and the cask is embedded in the northeast wall of the valve pit (the common wall with the loadout room). All valves in the pit had extension handles so they could be operated from the operating room. The waste in the line to the cask and from the cask could be sampled from the valve pit. A sample block in the cover block had removable pipe extensions to the two lines in the pit for the insertion of capillary tubes for a sampler.

A 1-in. drain line comes from the connector enclosure to the valve pit. Each of the four lines connecting the cask to the facility had a connector at the cask and one in an enclosure. If the connector in the enclosure leaked, the leakage drained to the valve pit.

As noted elsewhere, the valve pit has a floor drain that is routed to a dry well. Any leaks into the pit from the piping or connections would drain out the floor drain because only fluids could be pumped to the facility. Any leaks resulting in contamination would be flushed by the raw water nozzles in each corner of the pit. It is unlikely that any substantial quantity of waste remains in the pit.

2.4.1.3 Operating Room. The operating room is 8 ft wide by 14 ft long. It is accessed through a single personnel door in the southeast wall. The doorjamb is 6.2 ft below the grade on the southwest side of the building and slightly less than 2 ft above the loadout room floor. Controls in the room include the pushbuttons for operating the pump in 241-C-103, rotameters, air and raw water valves, two helium tanks, and a manifold. A 55-gal water-add drum was used to flush raw water through the waste lines from the valve pit to the cask. There is no waste line in the operating room, and historical radiation surveys indicate there is no source material in the room. One of the unit heaters (188 kW [55,000 Btu/h]) is in the room.

Ventilation for the operating room was provided by a fan between the operating room and the loadout room. A gravity louver in the personnel door provides a slight positive pressure in the operating room.

2.4.2 Material at Risk

The contents of the various components within the facility are not well defined. Inventories at risk can be estimated based on individual component volumes and historical data on material that came into the facility. There is no storage tank in the building. The design of the facility is such that it was a waste transfer facility. There is no evidence of waste in any of the accessible areas of the building. The design of the valve pit is such that it is extremely unlikely that there is any appreciable amount of waste there.

Any leakage or spills would have drained or been rinsed to the dry well.

Waste was not stored in the buildings. There is contamination from spills and/or leaks. The operating room and the loadout room contain no waste other than minor contamination and that which is contained within the piping to the cask area. The piping from the valve pit to the cask is in the shield wall to the connector enclosure. The piping from the floor drain to the dry well is buried in the concrete mat.

There was no chemical processing within the facility. Therefore there is no chemical inventory to present toxicological hazard with respect to the safety analysis. There may be two helium bottles in the operating room. This presents an industrial hazard only. The tanks may leak or even blow down affecting the surrounding area. They are not an explosion hazard.

2.4.3 Facility-Specific Concerns

The condition in the valve pit is unknown. Facilities were included for flushing the lines and the pit. However, a current inventory of material and/or radiation levels is not available.

Because of the limited volume of waste in the facility and the fact that any that is there is in pipes and not tanks, it is unlikely that a flammable gas issue exists. The possibility of gas migrating from a tank through the connecting lines cannot be discounted. Calculations in RPP-5926 demonstrate that, even if there is only barometric breathing in the feed tank (241-C-103), the flammable gas concentration in the tank headspaces would not reach the LFL.

The pump in tank 241-C-103 requires raw water for lubrication of its bearings when it is being started. The fact that raw water has been isolated to the facility means that the pump cannot have its bearings lubricated. Tank 241-C-103 has a capacity of 530,000 gal. The latest information, HNF-EP-1082-164, *Waste Tank Summary Report for Month Ending November 30, 2001,* states that there is approximately 83,000 gal of pumpable liquid (of which 79,000 gal is supernate) in 198,000 gal of waste. It further notes the tank has been "partially interim isolated" or has "...completion of the physical effort required for Interim Isolation except for isolation of risers and piping that is required for jet pumping or for other methods of stabilization."

2.5 241-A-431 VENTILATION BUILDING (A TANK FARM)

The 241-A-431 Ventilation Building includes the Fan House Building and four French drains: 216-A-16, 216-A-17, 216-A-23A, and 216-A-23B. It is also known as the SPJ Vent House; Fan House De-Entrainer Facility 241-A-431; 241-A-431 Ventilation House, Standby; and 241-A-431 Tank Farm Ventilation Building. It was constructed in 1953 to provide offgas de-entrainment for the six tanks in the A Tank Farm, and to receive drainage from the 296-A-11 Stack. It began operation in 1955 and was shut down in 1969.

The four French drains were transferred to Tank Waste Remediation System in 1998 and are included in Table 2-20 of the FSAR. Therefore, they are not part of the hazard evaluation, but the description is included for a more complete understanding of the facility.

2.5.1 Facility Description/Operation

As described below, the original vapor line to the de-entrainer came from two contact condensers. Attached to this vapor line was a drain that would drain the line to the original French drains (216-A-17 and 216-A-16). This drain and loop seal (inside the building) were removed, and a new drain and loop seal were added to the vapor line outside the building. This loop seal is significantly larger (eight to ten times) than the original. The loop seal also was routed to "new" French drains (216-A-23A and 216-A-23B) added south of the building. At about the same time the de-entrainer was physically changed out.

Another major change was made with the routing of a second 8-in. vapor line. This line was installed from 241-A-401, Surface Condenser Building. This line enters the building slightly above and to the west of the first line. It ties into the original line and enters the bottom of the de-entrainer.

The building is a reinforced concrete structure, 21 ft long (east-west) and 16 ft wide. The walls are 8 in. thick. Access is obtained through a personnel door in the west wall. The building is 25 ft high with 9 ft above grade. The below-grade portion is only in the de-entrainer room.

Besides the stack exhausting from the building, there are five lines connecting the building to processes and drains. One 4-in. drain line connects the bottom of the 24-in. stack to one of the French drain systems (216-A17, which overflows to 216-A-16). A second drain line connects to French drain 216-A-23A, which overflows to the 216-A-23B French drain. The specifics of the French drains are discussed below. There are also the 24-in. vapor header from the A Tank Farm, and two 8-in. vents, one (now isolated) from the 241-A-401 building (Surface Condenser Building), and the second from the contact condensers by valve pit 501.

2.5.1.1 Operating Room. The operating room extends the width of the building (16 ft) in the west part of the building. The floor is at grade level, and the height is 9 ft. It contains the fans, motors, and controls for the system. To the south side of the room is a passageway to the de-entrainer room to the east.

2.5.1.2 De-entrainer Room. The de-entrainer room extends the width of the building (16 ft) and is the remaining 11 ft of the building. It extends from 16 ft below grade to 9 ft above grade. It contains the de-entrainer, pipes, and the stack. The de-entrainer is a steel tank 10 ft high and 6.5 ft in diameter. Grade level includes a grating around the de-entrainer and stack, and a ladder provides access to the lower level.

The de-entrainer is a right cylindrical tank with the inlet at the bottom and the exhaust at the top. Just above the bottom dished head is a grating to hold the de-entraining material. Drawing H-2-55946, *Vent. D-Entrainer Details*, identifies the material as "Rashig Rings, 1" O.D. x 1" long x 1/8" wall, U.S. Stoneware or equal white porcelain." From the grating the tank is filled with the material to a depth of 5 ft in the 6 ft straight section of the tank. In the upper dished head, a spray ring is installed for backwashing the de-entrainer. Spray water could be connected to a pipe connector on the top of the tank. An inspection plate is provided at the level just above the Rashig rings but below the spray ring.

2.5.1.3 French Drains. The four French drains (216-A-16, 216-A-17, 216-A-23A, and 216-A-23B) are located in the southeast part of the A Tank Farm. They received drainage from the stack drain from 296-A-11, and the floor drain from the de-entrainer building. They were part of USQ TF-98-0977, *To Evaluate Cribs Not Addressed in the TWRS Authorization Basis [ECN: 644566]*, which addressed a total of seven cribs that were being transitioned to tank farms and were not adequately addressed in the AB. In an attachment to the USQ, the USQ author noted the following: "The source of the material sent to the drains did not contain high levels of either radioactive or other hazardous material. The WIDS [Waste Information Data System] data base contains information on the French drains and their contents."

The Waste Information Data System data sheets for French drains 216-A-16 and 216-A-17 describe the waste as follows, "The site received floor drainage and the 296-A-11 Stack drainage from the 241-A-431 Building. The waste is low salt, neutral/basic, and contains less than 10 curies total beta activity." These French drains are northeast of the building. Liquid from the floor of the de-entrainer pit drained through a loop seal to the buried lower portion of the stack. From there the liquids drained with liquids from the low point of the stack to 216-A-17. This dry well cascades to 216-A-16.

For French drains 216-A-23A and 216-A-23B, the data sheets report, "The site received the de-entrainer tank condensate and the back flush waste from the 241-A-431 Building. The waste is low salt, neutral/basic and contains less than 50 curies total beta activity. The total amount discharged by this waste stream, 6,000 liters (1,580 gallons), applies to both A-23A and A-23B." These French drains are located south of the building. Because the line to these French drains is connected to the bottom of the vapor line which is below the de-entrainer, it receives the liquids draining from the de-entrainer including back flush, condensation in the de-entrainer, and condensation in the vapor lines (which are pitched toward the building). The east dry well (216-A-23A) overflows to French drain 216-A-23B.

The drains were in operation from 1956 until they were isolated by a water seal in March 1969. The drains have been included in the FSAR, Table 2-21. For purpose of the AB, there is no inadequacy and, because they are already in the River Protection Project AB, they do not have to be transitioned. The discussion is included here for sake of completeness, but they are not included in the hazard evaluation.

2.5.1.4 Operation. The 24-in. vapor header from the tanks serves as a relief line for the six tanks in the A Tank Farm. From each tank a vapor line with a loop seal supplies relief protection. The six individual lines combine into the vapor header, which is routed to a seal pot (241-A-164). From the seal pot the header continues to 241-A-431 and enters the stack directly. According to statements from knowledgeable personnel, the vapor header has been filled with concrete between seal pot 241-A-164 and the building. Drawing H-2-56142, *Instrument Engr. Flow Diagram*, Rev 8, includes a comment at the bypass seal saying. "ISOLATED, FILLED WITH CONCRETE." It also notes the seal is, "OUT OF SERVICE." It is unlikely that waste would have been introduced through the pressure protection line that had water seal in the seal pot. If one or more of the tanks did experience an overpressure situation, any vapor would have exhausted up the stack and any liquid would have drained from the bottom of the stack to French drain 216-A-17.

The de-entrainment function was used for vapor from the surface condensers in 241-A-401 and/or from the contact condensers. Vapor from the six A Tank Farm tanks was drawn through a 24-in. line that tees into the above-mentioned relief line. The line ran to two contact condensers. From the top of the condensers, one vapor header runs parallel (actually above the 24-in. header). The vapor line ran downhill to 241-A-431, where it entered the building and then the bottom of the de-entrainer. From the bottom of the line a 4-in. drain line formed the original loop seal and entered the stack just above the concrete floor. This drain line was removed. Revision 8 of

Drawing H-2-62895, *IEFD Vent System Expansion*, notes that the loop seals to the contact condensers are "GROUT FILLED."

A second vapor header is identified on H-2-62895, sheet 3, as the 8" V-M30 Bypass. It is shown as having a valve in the line removed with the end of the pipe capped, effectively isolating 241-A-431 from the process. The line had originally teed into the outlet manifold for the three condensers in 241-A-401. (241-A-401 received vapor from the following farms: A [normally closed valve], AX, AY, and AZ.) The now-isolated connection was in a valve pit just outside the building. Non-condensibles could be routed in one of two directions at that point. They could be valved and drawn to 241-A-431, through the de-entrainer and out the stack, or the vapor could be routed through a valve pit and de-entrainer to filters and out the stack in 241-A-702. The vapor line between 241-A-401 and 241-A-431 ran uphill with a 1 percent pitch to the Ventilation Building. This line was added after the first vapor line, and enters the building above and slightly to the west of the first line. It is teed into the first line. There is no valving of the lines in the building. The branch of the tee not isolated now goes to a different building with filters, fans, and a stack. One could speculate that this vapor header to 241-A-431 was installed in anticipation of the new tanks but before the new ventilation system was functional. A comment on Drawing H-2-57940, *Condenser Cooling Tower, Sumps, Piping Schematic Diagram*, is "(This Vent Equipment is 'Backup' for New Vent and Filter Bldg 702-A)." The comment is referring to 241-A-431. The revision date is 1961. The same drawing identifies the contact condensers in the following manner, "Contact Condensers (2) (Used as 'Backup' for Surface Condensers)."

This vapor header from the surface condensers has a 1-in. drain line near 241-A-401. The drain forms a loop seal to a 6-in. line.

In either case (from the contact condensers or from 241-A-401), vapor was drawn from the tank vapor space through the 8-in. line through the de-entrainer. It exited the top of the tank through an 8-in. line to one of two fans in the operating room. The fans exhausted through individual butterfly valves to 6-in. lines to the stack, which extends 6 ft above the building. The "scrubbed" vapor from the exhausters entered the stack just above grade elevation.

2.5.1.5 Summary of Piping Connections. The 24-in. vapor header from the A Tank Farm probably does have a concrete plug in it in the form of the seal pot being filled with concrete. The 241-A-401 vapor header drain line is not isolated, but does not present a waste misroute situation. The vapor header from 241-A-401 is isolated. The line from the contact condensers is isolated by the grout in the lines between the tank farm and the condensers.

2.5.2 Material at Risk

The MAR in the Fan House De-Entrainer Facility includes contamination on the equipment, walls, and floor. There also may be some contamination on the inside of the pipes and other components. The other source of material is the de-entrainer. While the quantity and composition of the radioactive material in the de-entrainer are unknown, it is known that the radiation levels around the de-entrainer are not exceedingly high. As noted above, the data sheets for the French drains indicate a total of 60 Ci beta collected in the drains. That order of magnitude would be indicative of the amount in the building because the drains collected all liquid and any backwash of the de-entrainer. The design of the system is that the only material that would pass to the de-entrainer would be particulates and non-condensible gases from the condensers. Noble gases would not be captured. The facility has been shut down for more than three decades. The assumption is made that the MAR is limited.

3.0 HAZARDS IDENTIFICATION AND EVALUATION

The hazards identification and evaluation for the 241-SX-401, 241-SX-402, ITS1, 241-A-431, 241-C-801, and 241-AX-IX facilities used a combination of the preliminary hazards analysis and hazard and operability analysis methods. One interdisciplinary team evaluated the 241-SX-401, 241-SX-402, and ITS1 facilities, and another team evaluated the 241-A-431, 241-C-801, and 241-AX-IX facilities to identify hazardous conditions associated with the continued maintenance of these facilities in a standby condition. The preliminary hazards analysis process evaluated basic chemicals, reactions, and process parameters known to be present in the facility. The use of the hazard and operability analysis set of process parameters (e.g., flow, temperature, pressure) and guide words (e.g., high, low, less, more) provided additional structure to the preliminary hazards analysis process. Table 3-1, located at the end of this section, shows the process parameters, guide words, and deviations used to facilitate hazards evaluation process.

The teams of facility/process experts were systematically guided by a facilitator through an evaluation of potential hazards in the six facilities. During the evaluation of these facilities, potential hazardous conditions were postulated and possible corrective and/or preventive measures identified and discussed. The preliminary hazard analysis process was derived from MIL-STD-882, *System Safety Program Requirements*. This process is recognized by the American Institute of Chemical Engineers and is described in *Guidelines for Hazard Evaluation Procedures*. The information was recorded using a tabular format. The data generated by the two teams were combined into one table.

Because the results of the hazards evaluation process tend to be qualitative in nature, the expertise and experience of the two teams' members are of primary importance in establishing the credibility of the analysis. Appendix A provides a short resume of each team member to document the expertise and experience level of each team member.

3.1 METHODOLOGY

The evaluation teams met to develop the raw data. The information was recorded systematically in a tabular format. The following sections describe the table structure, information recording details, and process node descriptions.

3.1.1 Hazard and Operability Analysis Table

The 241-SX-401, 241-SX-402, ITS1, 241-A-431, 241-C-801, and 241-AX-IX facilities table (Appendix B, Table B–1) was structured to ensure a systematic and thorough documentation of the potential hazards. The table captured the following information:

- **ID:** The item identification. Used to record a unique identifier for the hazardous condition. The identifier is in the form of a hyphenated number, the part preceding the hyphen indicating the facility and the part following the hyphen being a sequential number to preserve uniqueness.

- **Location/Activity:** More detailed description of the individual activities being evaluated under a node.
- **Hazardous Condition:** The hardware failures, operational faults, or conditions that could result in undesired consequences in the facility being evaluated.
- **Candidate Deviation:** The causes that lead to the hazardous condition. Identifying causes is important to identifying potential preventive or mitigative controls or features for significant hazardous conditions as well as potential consequences. In many cases, multiple hardware or operational faults are required to produce a hazardous condition. This column identifies the sequence of hardware and operational faults required to produce the postulated hazardous condition.
- **Material at Risk:** A qualitative estimate of the type, form, and quantity of material that can become the source term of an accident.
- **Immediate Consequence:** A qualitative estimate of the potential consequences that could result from the postulated deviation.
- **Eng Safety Features:** Systems, structures, and components (SSC) are existing engineered features (hardware items) identified by the team that have the potential to mitigate or prevent the hazardous condition of concern. The engineered features are candidates for designation as safety significant items for hazardous conditions that pose a significant threat to the health of facility workers and onsite personnel, or safety class for hazards that pose a significant threat to offsite individuals. These items should not be construed as being the "official" controls that would eventually be credited in the AB. They are identified to aid in future control selection activities associated with consequence analysis.
- **Admin Safety Features:** Administrative controls are existing controls identified by the team that have the potential to mitigate or prevent the hazardous condition of concern. These items should not be construed as being the "official" administrative features that would eventually be credited in the AB. They are identified to aid in future control selection activities associated with consequence analysis.
- **Cons Cat NC:** The consequence ranking is a "first cut," qualitative estimate of the safety severity of the consequences, assuming no controls are present. The ranking is used as part of the accident screening process. The consequence category is a code designator for the level of consequence associated with a hazardous condition. The following system is used:
  - S0 Negligible safety concerns for the facility worker.
  - S1 Potential industrial injury, low radiological or chemical exposure dose consequences to the facility worker.
  - S2 Potential significant radiological dose consequences or chemical exposure to onsite workers located outside the facility.

  - S3 Potential significant radiological dose consequences or chemical exposure to the offsite population.

- **Freq Cat NC:** The frequency category is a "first cut," qualitative estimate of the likelihood of the hazardous condition assuming no controls are present. The ranking is used as part of the accident screening process. The following coding system is used:

  - F3 Hazardous conditions that are expected to occur one or more times during the lifetime of the facility, categorized as "anticipated" events. The frequency range associated with this category is 1E-02/yr to 0.1/yr.

  - F2 Hazardous conditions that could occur during the lifetime of the facility, but with low probability. Such events are categorized as "unlikely" and fall in the range of 1E-04/yr to 1E-02/yr.

  - F1 Hazardous conditions not expected to occur during the lifetime of the facility, categorized as "extremely unlikely." The frequency range associated with this category is 1E-06/yr to 1E-04/yr.

  - F0 Hazardous conditions categorized as "beyond extremely unlikely," with a frequency less than 1E-06/yr. Events in this category (such as meteor strike) are so unlikely they generally do not require special controls.

- **Env Cat:** The environmental consequence ranking is a "first cut," qualitative estimate of the environmental severity of the hazardous condition assuming no controls are present. The ranking is used as part of the accident screening process. The following coding system is used:

  - E0 No significant environmental effect outside the facility confinement systems.

  - E1 Limited environmental discharge of hazardous material outside the facility.

  - E2 Large environmental discharge of hazardous material within the plant site boundary.

  - E3 Significant environmental discharges of hazardous material outside the plant site boundary.

- **Remarks:** Miscellaneous observations or clarifying comments for information captured in a given item.

Nomenclatures used in Appendix B, Tables B-2, B-3, and B-4 are consistent with the preceding descriptions.

The following additional nomenclatures are used in Appendix B, Table B-5:

- **Potential Prev SSC** – SSCs from the analyzed accident in the AB, determined by this hazards evaluation to apply to the hazardous condition, that provide a preventive function.
- **Potential Prev TSR** – Technical safety requirements (TSR) from the analyzed accident in the AB, determined by this hazards evaluation to apply to the hazardous condition, that provide a preventive function.
- **Potential Mit SSC** – SSCs from the analyzed accident in the AB, determined by this hazards evaluation to apply to the hazardous condition, that provide a mitigative function.
- **Potential Mit TSR** – TSRs from the analyzed accident in the AB, determined by this hazards evaluation to apply to the hazardous condition, that provide a mitigative function.

The following additional terms derived from HNF-SD-WM-TI-764, *Hazard Analysis Database Report*, have been used in Appendix B, Table B-5:

- BIN – A code that describes the release attributes for high safety consequence (S2 and S3) and worker hazard (S1) with anticipated frequency (F3) hazardous conditions.
- Cause Grp – An alpha/numeric code used to permit sorting of data by the cause of a hazardous condition.
- MAR – Material at risk. A description of the type and quantity (when applicable) of material that may be affected by the occurrence of a hazardous condition.
- Rep Acc – Representative accident. An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned representative accidents.

3.2 MAJOR ASSUMPTIONS

Throughout the text of this report there are descriptions of facilities. These descriptions have been developed from a variety of sources. When the hazard evaluation panel met, it had to make certain conservative assumptions. These assumptions may not be entirely consistent with the various sections of the report, but were used in the creation of the hazards database and classification of the various events. This inconsistency occurred because of either lack of confidence in the information at the time, or additional information collected following the meetings.

The hazard evaluation panel met June 13 and 14, 2000. Based on the limited information available at the time, a categorization was accomplished. The specific assumptions, as developed during the team meetings, that are unique to this hazard evaluation are described in the following discussion.

3.2.1 Facility Common Features

- All facilities are abandoned.
- No maintenance is being performed on these facilities.
- The facilities are mostly aboveground.
- There is limited knowledge about these facilities.
- No facility contains tanks of waste.

3.2.2 Facility Isolation Status

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- Condensate goes to the crib, and there is no isolation from the line to the crib.
- Condensate pathways between 241-SX-401 and 241-SX-402 and respective tanks are isolated.
- Vapor pathway is isolated, but 241-SX-402 might be by a single valve.
- Dry wells outside of buildings are still connected to the facility.
- Condenser isolation valves are closed in 241-SX-401.
- Condenser isolation valves and/or the 24-in. vapor isolation valves of 241-SX-402 are closed.
- Instrumentation tubing goes from the Control Building to the condensers.

ITS-1

- There is no misroute issue.
- There may be a direct connection (drain line with valve) between 241-BY-102 and ITS1.

241-A-431 Ventilation Building

- Seal pot A-164 has not been maintained full of water.
- The AY Tank Farm is isolated from the 241-A-431 vapor header.
- The 24 in. 241-A-431 vapor header has been blocked with concrete, isolating the A Tank Farm from the vapor header.

- The dry wells do not present any unusual hazard, and they have been characterized in a USQ.
- The 241-A-431 Ventilation Building is isolated from the 241-A-401 building.

241-C-801Cesium Loadout Facility

- The facility is not isolated from tank 241-C-103.

241-AX Ion Exchanger

- The ion exchanger is fully isolated.
- It is difficult to get a large vehicle into the area.

3.2.3 Facility Structure

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- The Control Buildings are wood.
- The other portions of the buildings are reinforced concrete.
- The buildings are 7 ft below grade, and 15 ft above grade.
- No floor drain was found in the building.

ITS-1

- The layup conditions for this facility are unknown.
- Other than wind-blown debris, there is no combustible material.
- There is no pump in the system except in the solution holdup tank, and its status is unknown.
- Structural elements will not be degraded by corrosion to the point where it will be a problem.

241-A-431 Ventilation Building

- The facility structure is in good shape; however, the roof condition is unknown.
- The building is not hermetically sealed and will breathe.
- The building has been through many freezing cycles with no apparent releases.
- High ambient temperatures are not a problem.

241-C-801 Cesium Loadout Facility

- This is a concrete structure below grade, and a metal frame building above grade.

241-AX Ion Exchanger

- The 241-AX-IX facility does not have a building surrounding the system components.

3.2.4 Facility Ventilation

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- Tank SX-101-106 is actively ventilated; tanks SX-101, -102, and -103 and tanks SX-104, -105, and -106 potentially communicate via cascaded overflow lines.
- The facilities have no building ventilation system.

ITS-1

- ITS1 is not actively ventilated; it is outdoors.

241-A-431 Ventilation Building

- The building is not hermetically sealed, and will breathe.
- There are filters in this facility, but the type is unknown.

241-C-801 Cesium Loadout Facility

- The building is naturally ventilated.

241-AX Ion Exchanger

- The facility is unenclosed and has no ventilation system.

3.2.5 Facility Water Sources

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- These facilities are isolated from any raw water supply.
- There is no fire protection system.

ITS-1

- Raw water is isolated at the tank farm boundary.

241-A-431 Ventilation Building

- There is no raw water connected to this facility.

241-C-801 Cesium Loadout Facility

- Raw water, compressed air, and steam are unavailable.

241-AX Ion Exchanger

- Raw water is unavailable.

3.2.6 Building Electrical Systems

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- The facilities are energized.
- There is no active instrumentation in these facilities.

ITS-1

- The facility electrical status is unknown.

241-A-431 Ventilation Building

- The facility electrical status is unknown.

241-C-801 Cesium Loadout Facility

- The facility electricity status is unknown.

241-AX Ion Exchanger

- There is no electrical supply to the facility.

3.2.7 Personnel Presence in Facility

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- No access to this building has occurred for several years.

ITS-1

- Operational activities are to check the barricade weekly to ensure dose rates do not increase.

241-A-431Ventilation Building

- No access to this building has occurred for several years.

241-C-801 Cesium Loadout Facility

- No access to this building has occurred for several years.

241-AX Ion Exchanger

- The facility is not enclosed to prevent personnel access.
- It would be quite difficult to get a large vehicle into the area.

3.2.8 Building Material at Risk

241-SX-401 and 241-SX-402 Condenser Shielding Buildings

- MAR is residual contamination in tanks, condensers, ductwork, and piping; it consists mostly of cesium.
- MAR quantity is low, uniformly distributed throughout piping and not in one spot, with the exception of one hot spot in one tank in 241-SX-401.
- MAR is radioactive only, and no other hazards are associated with it.
- The vaporization process in the radioactive waste tanks was not a vigorous process, and did not entrain many solids.
- Potential release consequences do not reach offsite consequence levels.
- Condensate that went to the crib was very low in radiation levels.
- The liquid inventory is a maximum of 150 gal per tank.
- 241-SX-401 and 241-SX-402 are essentially the same, with 241-SX-402 having lower contamination and exposure levels.
- The flammable gas hazard could be in the pipes; flammable gas monitoring is done periodically.
- There are no chemicals in the tanks or process lines that are associated with any treatment.
- No nitrates are expected in vapor ducting.
- All waste was neutralized before storage in waste tanks.
- There could be extraneous materials stored in the facilities.

ITS-1

- The ion exchange resin is a potential worker hazard.
- There is the potential for flammable gas presence (self-generated or from 241-BY-102).
- The radiation source term is similar to (no worse than) the source term in 241-BY-102.
- The asbestos coatings in the facility can be breached, and the asbestos can be disturbed.
- There may be some residual chemicals in the solution holdup tank.
- The filter has significant contaminants.
- The ion exchange column also has significant contaminants, and is in a shielded location.
- Enough source term is available to produce onsite consequences.
- The source term has had 26 years of decay.

241-A-431 Ventilation Building

- There are no hazardous chemicals or compressed gases stored in this facility.
- When it was in operation, one of two parallel fans drew air from the de-entrainer and discharged it into the stack.
- The building is contaminated, but a person located 328 ft away would not be affected by release of the building contamination.
- The de-entrainer and internals of the piping contain radioactive material. There was some carryover particulate from the A Tank Farm. There is insufficient material in the de-entrainer and piping to result in an offsite consequence (maximum consequence category of S2).
- The radiation fields in the facility do not preclude personnel entry.
- There is asbestos in this facility; its physical status is unknown.
- The original de-entrainer was replaced with a new one.

241-C-801 Cesium Loadout Facility

- Tank 241-C-103 has a floating organic layer.
- There is no ion exchange material and no cesium cask in this facility.
- The facility is not isolated from tank 241-C-103.

- The facility is cleaned up, there is no significant combustible loading, and no chemicals are present.

241-AX Ion Exchanger

- Radiation levels are unknown; the ion exchanger and the filter are shielded.
- Resin is still in the ion exchanger.
- It is unknown whether the resin tank is full of water or dry.
- It is unknown whether the ion exchange resin was regenerated after its last use.
- Condensate catch tank 241-A-417 is addressed in the FSAR.

Table 3-1. Hazard and Operability Analysis Deviation Guide.

Process Parameter	Guide Words						
	NO, NOT, NONE	LESS, LOW, SHORT	MORE, HIGH, LONG	PART OF	AS WELL AS, ALSO	OTHER THAN, WHERE ELSE	REVERSE
FLOW	No Flow	Low Rate, Low Total	High Rate, High Total	Misdirection, Missing Ingredient	Misdirection, Contamination, Impurities	Wrong Material	Backflow
PRESSURE	Open to Atmosphere	Low Pressure	High Pressure				Vacuum
TEMPERATURE	Freezing	Low Temperature	High Temperature				Auto-refrigeration
LEVEL	Empty	Low Level	High Level	Low Interface	High Interface		
CONFINEMENT	No Confinement	Degraded Confinement				Bypass Pathway	
TIME PROCEDURE	Skipped or missing Step	Too Short, Too Little	Too Long, Too Much	Action(s) Skipped	Extra Action(s) (Shortcuts)	Wrong Action	Out of Order, Opposite
SPEED	Stopped	Too Slow	Too Fast	Out of Synch		Web or Belt Break	Backward
COMPOSITION/ CONCENTRATION	Missing Ingredient	Less Ingredient/ Low Concentration	More Ingredient/ High Concentration	Missing Ingredient	Contaminant/ Additional Ingredient	Wrong Ingredient	
pH		Low pH	High pH		Additional Acid, Additional Base	Wrong Acid, Wrong Base	
VISCOSITY		Low Viscosity	High Viscosity				
VOLTAGE	No Voltage	Voltage Low	Voltage High	Wrong Waveform	Interference Voltage	Wrong Frequency, AC instead of DC DC instead of AC	Wrong Polarity
CURRENT	No Current	Current Low	Current High			Current Fluctuating	Wrong Polarity
STATIC			Static Charge				
AGITATION	No Mixing	Poor Mixing	Excessive Mixing	Mixing Interruption	Foaming		Phase Separation
REACTION	No Reaction	Slow Reaction	Runaway Reaction	Partial Reaction	Side Reaction	Wrong Reaction	Decomposition
STRUCTURAL INTEGRITY	Structural Failure	Less Integrity	More Integrity				
SHIELDING		Less Shielding	More Shielding				
SPECIAL	Utility Failure	External Leak	External Rupture	Tube Leak	Tube Rupture	Startup, Shutdown, Maintenance	

4.0 EVALUATION RESULTS

The hazard evaluation teams identified potential hazardous conditions associated with the 241-SX-401, 241-SX-402, ITS1, 241-A-431, 241-C-801, and 241-AX-IX facilities and qualitatively assigned frequency of occurrence and severity of consequence. This analysis evaluated these hazardous conditions, as stated below, according to the guidance given in Chapter 3 of the FSAR to identify applicable existing AB analyses and controls:

- Each hazardous condition that was assigned a consequence category of S2 or S3 was evaluated to identify the potentially applicable AB representative accident. These hazardous conditions were also evaluated to identify potentially applicable safety SSCs and TSRs.

- Hazardous conditions that were assigned a consequence category of S1 and a frequency category of F3 were evaluated to identify potentially applicable safety SSCs, operational controls, or programmatic requirements that protect the facility worker.

- Any hazardous condition having an assigned environmental consequence category of E2 or E3 was evaluated to identify potentially applicable safety SSCs, operational controls, or programmatic requirements that protect the environment.

- Hazardous conditions having an assigned consequence category of S1 and a frequency category of F2 or F1 were not evaluated further. This also was true of any hazardous condition having an assigned consequence category of S0 (negligible safety concern) or an assigned frequency category of F0 (beyond extremely unlikely).

This document is not part of the AB, and is not a vehicle for requesting authorization of any activities. It is only intended to identify and categorize hazardous conditions that might result in injury or exposure of facility workers, onsite workers, or offsite individuals to radioactive or toxic materials present in the 241-SX-401, 241-SX-402, ITS1, 241-A-431, 241-C-801, and 241-AX-IX facilities. The AB control decision process will be used to determine the controls for each hazard. The results of this evaluation will be used to support closure of USQ TF-98-0785.

Eighty-one hazardous conditions were identified for the six facilities as a result of the hazard evaluation process. These hazardous conditions are shown in Appendix B, Tables B–1a through B-1f, broken down by facility. The results of the hazards evaluation process for each facility are presented below.

4.1 241-AX-IX ION EXCHANGER (AX TANK FARM)

No hazardous conditions were assigned a consequence category greater than S1. Five S1 consequence category hazardous conditions (Table B-3b), and one S0 consequence category hazardous condition (Table B-4b) were identified. These tables contain the ID, Hazardous Condition, Candidate Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Consequence Category (Env Cons).

Table B-6b of Appendix B presents the potential applicability of current Tank Waste Remediation System AB controls to the single S1-F3 category hazardous condition. No hazardous conditions were identified for which the AB control strategies would not apply.

4.2 IN-TANK SOLIDIFICATION SYSTEM (BY TANK FARM)

No hazardous conditions were assigned a consequence category greater than S2. Three of the hazardous conditions were assigned an S2 consequence category (Table B-2c), seven an S1 consequence category (Table B-3d), and five an S0 consequence category (Table B-4d). These tables contain the ID, Hazardous Condition, Candidate Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Consequence Category (Env Cons).

The three S2 consequence category hazardous conditions are potentially bounded by Rep Acc 05, Flammable Gas Deflagration-SST. Table B-5c presents the hazardous conditions by potential Rep Acc. This table contains the BIN, ID, Hazardous Condition, Cause, Existing Engineered Safety Features, Existing Admin Safety, Freq Cat NC, Cons Cat NC, Cause Grp, and Rep Acc. The BIN, Cause Grp, and Rep Acc shown in Table B-5a were derived from HNF-SD-WM-TI-794. These additional column identifiers are defined as follows:

- BIN – A code that describes the release attributes for high safety consequence (S2 or S3) and worker hazard (S1) with anticipated frequency (F3) hazardous conditions.
- Cause Grp – An alpha/numeric code used to permit sorting of data by the cause of a hazardous condition.
- Rep Acc – Representative accident. An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned representative accidents.

Table B-6d of Appendix B presents the potential applicability of current Tank Waste Remediation System AB controls to the S2 and S1-F3 category hazardous conditions. No hazardous conditions were identified for which the AB control strategies would not apply.

4.3 241-SX-401 AND 241-SX-402, CONDENSER SHIELDING BUILDINGS (SX TANK FARM)

241-SX-401 and 241-SX-402 are essentially identical facilities. 241-SX-402 may have lower inventories of radioactive material as compared to 241-SX-401, because of different operating histories. For this hazards analysis the two facilities were assumed to be identical, but were given separate hazards evaluation tables.

No hazardous conditions were assigned to the S2 consequence category. Nine of the hazardous conditions were assigned an S1 consequence category for each facility (Tables B-3e and B-3f of Appendix B), and eight an S0 consequence category for each facility (Tables B-4e and B-4f). These tables contain the ID, Hazardous Condition, Candidate Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Consequence Category (Env Cons).

Tables B-6e and B-6f of Appendix B present the potential applicability of current Tank Waste Remediation System AB controls to the S1-F3 category hazardous conditions for each facility. No hazardous conditions were identified for which the AB control strategies would not apply.

4.4 241-C-801 CESIUM LOADOUT FACILITY (C TANK FARM)

No hazardous conditions were assigned a consequence category greater than S2. One of the hazardous conditions was assigned an S2 consequence category (Table B-2b), nine an S1 consequence category (Table B-3c), and one an S0 consequence category (Table B-4c). These tables contain the ID, Hazardous Condition, Candidate Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Consequence Category (Env Cons).

The S2 consequence category hazardous condition is potentially bounded by Rep Acc 15, Spray Leak in Structure or from Over Ground Waste Transfer Lines. Table B-5b presents the hazardous conditions by potential Rep Acc. This table contains the BIN, ID, Hazardous Condition, Cause, Existing Engineered Safety Features, Existing Admin Safety, Freq Cat NC, Cons Cat NC, Cause Grp, and Rep Acc. The BIN, Cause Grp, and Rep Acc shown in Table B-5b were derived from HNF-SD-WM-TI-794, *Hazard Analysis Database Report.* These additional column identifiers are defined as follows:

- BIN – A code that describes the release attributes for high safety consequence (S2 or S3) and worker hazard (S1) with anticipated frequency (F3) hazardous conditions.
- Cause Grp – An alpha/numeric code used to permit sorting of data by the cause of a hazardous condition.
- Rep Acc – Representative accident. An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned representative accidents.

Table B-6c of Appendix B presents the potential applicability of current Tank Waste Remediation System AB controls to the S2 and S1-F3 category hazardous conditions. No hazardous conditions were identified for which the AB control strategies would not apply.

4.5 241-A-431 VENTILATION BUILDING (A TANK FARM)

No hazardous conditions were assigned a consequence category greater than S2. Five of the hazardous conditions were assigned an S2 consequence category (Table B–2a), four an S1 consequence category (Table B-3a), and five an S0 consequence category (Table B-4a). These tables contain the ID, Hazardous Condition, Candidate Cause, Frequency Category without Controls (Freq Cat NC), and the Environmental Consequence Category (Env Cons).

Of the five S2 consequence category hazardous conditions, one is potentially bounded by Rep Acc 05, Flammable Gas Deflagration-SST, and four are potentially bounded by Rep Acc 34, Aboveground Tank Failure due to Excessive Loads. Table B-5a presents the hazardous conditions by potential Rep Acc. This table contains the BIN, ID, Hazardous Condition, Cause, Existing Engineered Safety Features, Existing Admin Safety, Freq Cat NC, Cons Cat NC, Cause Grp, and Rep Acc. The Bin, Cause Grp, and Rep Acc shown in Table B-5a were derived from HNF-SD-WM-TI-764. These additional column identifiers are as follows:

- BIN – A code that describes the release attributes for high safety consequence (S2 or S3) and worker hazard (S1) with anticipated frequency (F3) hazardous conditions.

- Cause Grp – An alpha/numeric code used to permit sorting of data by the cause of a hazardous condition.

- Rep Acc – Representative accident. An alpha/numeric code used to specify the analyzed accident in the FSAR. Only hazardous conditions with high safety consequence (S2 or S3) are assigned representative accidents.

Table B–6a of Appendix B presents the potential applicability of current Tank Farms AB controls to the S2 and S1-F3 category hazardous conditions. No hazardous conditions were identified for which the AB control strategies would not apply.

Note: When the hazard evaluation was performed, the amendment process for 242-T evaporator had progressed to the point that an accident analysis had been performed and a draft AB amendment had been prepared. That draft amendment included a new Representative Accident (#34). Because of the similarity of the hazardous condition for 242-T and 241-A-431, the hazard evaluation panel tentatively binned the 241-A-431 hazardous conditions that were anticipated to have on-site consequences in excess of guidelines under the proposed new representative accident. It was thought that the 242-T amendment would be approved well before the amendment for 241-A-431 or in the worst case at the same time. However, due to unforeseen circumstances, the plan in the spring of 2002 is to submit the amendment for 241-A-431 before the amendment for 242-T. Therefore, there is no Representative Accident #34.

5.0 CONCLUSIONS

The hazard evaluation for the 241-SX-401, 241-SX-402, ITS1, 241-A-431, 241-C-801, and 241-AX-IX facilities identified 81 hazardous conditions for the six facilities as a result of the hazard evaluation process. No hazardous conditions were identified for which the AB control strategies would not apply.

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APPENDIX A

HAZARD AND OPERABILITY STUDY TEAM BIOGRAPHICAL INFORMATION

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APPENDIX A

HAZARD AND OPERABILITY STUDY TEAM BIOGRAPHICAL INFORMATION

Jeff Doeler – Information not available.

William H. Grams – B.S. Mining Engineering, M.S. Mechanical Engineering. Experience includes licensing engineer for Tank Waste Remediation System; development and implementing Authorization Basis licensing strategies for new waste retrieval equipment and processes; preparation of Unreviewed Safety Question documentation; development and implementation of a low-level waste certification program including conduct of waste management audits, review and approval of certification plans, and direct assistance to waste generators; preparation of waste management disposal instructions including characterization requirements, packaging specifications, regulatory requirements; and evaluation and characterization of low-level waste streams.

Tomoko V. Jensen-Otsu – B.S. Physics. Assisted facilitation of 242-S Evaporator hazard and operability analysis. Hanford Site experience in updating and performing consistency checks for the Final Safety Analysis Report and Basis for Interim Operations hazard analysis information.

Milton V. Shultz, Jr. – B.S. Nuclear Engineering Technology. Facilitator for the 242-S Evaporator hazard and operability analysis. More than 25 years of experience in a broad range of engineering and technical assignments at the Hanford Site. Experience includes leading preliminary hazards analysis and hazards and operations for a variety of River Protection Project activities, including several for the Final Safety Analysis Report and Basis for Interim Operation efforts, and contributor to the hazards analysis work for the Final Safety Analysis Report. He has performed independent nuclear safety evaluations of reactor plant design and operation at the Hanford Site N Reactor.

James J. Zach – B.S. Mechanical Engineering; PE. Nine years consulting in the U.S. Department of Energy complex and nuclear utilities. Has been involved in assessing training programs and developing accreditation programs, participated in nuclear plant performance evaluations, advised strategy for regulatory compliance, and determined appropriate facility response to natural phenomena (lightning). Twenty-two years of experience at a two-unit nuclear power plant in various management positions, including plant manager and vice president responsible for nuclear safety, regulatory compliance, communications with the public, operations, maintenance, security, radiation protection, and engineering.

Paul Zalubil – B.S., Mechanical Engineering. Thirty years of experience in mechanical design and construction. Twenty years of Hanford Site experience.

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APPENDIX B

HAZARD EVALUATION TABLES

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Table B-1a. 241-A-431 Ventilation Building (A Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
A431-01a1	241-A-431 Vent Building structure	Release of radioactive contamination to the environment due to collapse of building structure caused by earthquake	Earthquake causes building structural failure (building and equipment not seismically qualified)	Building and internal (de-entrainer and piping) contamination	Radioactive contamination release to the environment (dispersal of contamination in failed equipment)	None	None	S2	F2	E2	Seismic events can result in failure of the building, but the frequency is unlikely based on poured concrete construction.
A431-01a2	241-A-431 Vent Building structure	Release of radioactive contamination to the building due to breach of de-entrainer caused by earthquake	Earthquake causes de-entrainer breach (equipment not seismically qualified)	Internal (de-entrainer and piping) contamination	Radioactive contamination release to the building from failed equipment	None	None	S1	F3	E1	De-entrainer structure support structure is not seismically qualified.
A431-01b1	241-A-431 Vent Building structure	Release of radioactive contamination from facility to the environment due to building collapse caused by loss of structural integrity caused by aging	Building structure degradation and failure due to aging	Building and internal (de-entrainer and piping) contamination	Radioactive contamination release to the environment	None	None	S2	F2	E2	Building structural degradation can result in failure of the building, but this event is unlikely for this type of facility.
A431-01b2	241-A-431 Vent Building structure	Release of radioactive contamination from de-entrainer to the building due to loss of de-entrainer support structure integrity caused by aging	De-entrainer support structure degradation and subsequent failure due to aging effects	Internal (de-entrainer and piping) radioactive contamination	Radioactive contamination release to the building	None	None	S1	F3	E1	Support structure degradation can result in failure of the de-entrainer. This event is not unusual for this type of facility.

Table B-1a. 241-A-431 Ventilation Building (A Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
A431-01c	241-A-431 Vent Building structure	Release of radioactive material to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event) caused by operator error or equipment failure	Building and internal (de-entrainer and piping) contamination	Radioactive release to the environment	None	None	S2	F0	E2	The facility construction resembles a "pill box" and consists of poured concrete. Extreme vehicle velocities would be required to penetrate the building.
A431-01d	241-A-431 Vent Building structure	Release of radioactive material to the environment due to loss of structural integrity caused by structural overload	Heavy snow, ashfall, high wind, etc., exceed structure load capacity	Building and internal (de-entrainer and piping) contamination	Radioactive release to the environment	None	None	S2	F1	E2	None.
A431-02	241-A-431 Vent Building structure	Release of contamination from building to the environment due to flooding	Snow melt, heavy rain flood the building sufficiently to move contamination outside the building	Building contamination	Minor contamination release to the environment	Floor drain goes to French drain	None	S0	F3	E1	F3 based on the roof leaking and the environmental release is not permitted by the current *Washington Administrative Codes*. S0 based on the small quantity of contamination available for dispersal.
A431-03a	241-A-431 Vent Building de-entrainer	Release of radioactive contamination to the environment due to loss of leak from the de-entrainer	Structural degradation due to corrosion results in leak of contamination	Residue on the de-entrainer	Contamination of the building and potential movement of contamination to the dry well	Drain	None	S0	F3	E1	By design, the de-entrainer drains to the French drain. The liquid in the de-entrainer has probably vaporized due to high temperatures.

Table B-1a. 241-A-431 Ventilation Building (A Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
A431-03b	241-A-431 Vent Building de-entrainer	Release of radioactive material to the environment due to loss of structural integrity of the de-entrainer	Failure of supporting structures causes breach in de-entrainer and release of contamination	Residue on the de-entrainer	Contamination of the building and potential movement of contamination to the dry well	Drain	None	S0	F3	E1	By design the de-entrainer drains to the French drain. The liquid in the de-entrainer has probably vaporized due to high temperatures.
A431-04	241-A-431 Vent Building de-entrainer	Release of radioactive aerosols to the environment due to hydrogen generation and ignition within the de-entrainer	Potential flammable gas migration from A Tank Farm or generation within the de-entrainer (with ignition source, e.g., sampling activities, lightning, present)	Residue on the de-entrainer	Potential release of contamination to the environment	None	Flam Gas Mon Cntrls Ign Cntrls	S2	F0	E2	S2 based on uncertainty of quantity of material gas present. F0 based on no potential mechanism for hydrogen generation.
A431-05	241-A-431 Vent Building de-entrainer	Release of radioactive material to the environment due to backflow through 1-in. drain to 8-in. vent	Backup of drain due to external causes outside of 241-A-431 disturbs contamination in de-entrainer	Residue on the de-entrainer	Potential release of contamination to the environment	None	None	S0	F2	E1	Any backflow to the de-entrainer will drain to the dry well. Quantity of radioactive material in the de-entrainer is small.

Table B-1a. 241-A-431 Ventilation Building (A Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
A431-06	241-A-431 Vent Building stack	Release of radioactive material to the environment due to A Tank Farm pressurization of 241-A-431 vapor header	The vapor header in communication with the A Tank Farm experiences headspace pressurization	Headspace atmosphere and residue in the stack	Potential release of tank atmosphere to the environment (unfiltered)	None	None	S1	F0	E1	Each of the six tanks in A Tank Farm has a passive breather filter with a seal loop designed to evacuate at 6-in. water gage to prevent any significant pressurization. F0 because vapor header is isolated from any pressure sources. There are facility group 2 and 3 tanks in A Tank farm.
A431-07	241-A-431 Vent Building stack	Release of radioactive material to the environment due to inadvertent start of the vent fans	Human error results in startup of vent fans	Stack residue and potentially what is trapped in the de-entrainer	Release of de-entrainer piping particulates to the atmosphere	None	Operator Procedures	S1	F1	E1	It is not evident that there is an inlet flow path. For this evaluation it is assumed to exist. F1 based on the many steps needed to reactivate and run the fans.
A431-08	241-A-431 Vent Building roof ventilator	Release of radioactive material to the environment due to inadvertent start of the roof ventilator	Human error results in startup of roof ventilator	Contamination in the building	Release of contamination	None	Operator Procedures	S0	F1	E0	F1 based on the many steps needed to reactivate and run the roof ventilator.

Table B-1b. 241-AX-IX Ion Exchanger (AX Tank Farm) Preliminary Hazards Analysis Data. (2 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
AXIX-01a	241-AX-IX ion exchanger structure	Release of radioactive materials to the environment due to shielding collapse and resin tank breach caused by earthquake	Earthquake (equipment not seismically qualified) causes shielding structure collapse with resulting breach of resin tank	Internal contamination of ion exchanger	Radioactive contamination release to the environment from the resin tank	None	None	S1	F2	E1	Seismic events and building degradation can result in failure of the structure. S1 based on results of radiation survey that showed dose rates very near background levels for resin tank. To have release event the tank would have to be breached.
AXIX-01b	241-AX-IX ion exchanger structure	Release of radioactive materials from the resin tank to the environment due to shielding structure collapse caused by structural degradation from aging	Shielding structure collapse and resin tank rupture caused by age-related degradation	Internal contamination of ion exchanger	Radioactive contamination release to the environment from the resin tank	None	None	S1	F2	E1	Building degradation can result in failure of the structure. S1 based on results of radiation survey that showed dose rates very near background levels for resin vessel.
AXIX-01c	241-AX-IX ion exchanger structure	Release of radioactive materials from the resin tank to the environment due to resin tank breach caused by failure of shielding structure from vehicle impact	Vehicle impact (this is an unlikely event) with shielding structure results in structure failure and resin tank breach	Internal contamination of ion exchanger	Radioactive contamination release to the environment	None	None	S1	F2	E1	S1 based on results of radiation survey that showed dose rates very near background levels for resin vessel.

Table B-1b. 241-AX-IX Ion Exchanger (AX Tank Farm) Preliminary Hazards Analysis Data. (2 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
AXIX-01d	241-AX-IX ion exchanger structure	Release of radioactive materials from the ion exchanger to the environment due to breach of resin tank caused by shielding structure overload caused failure	Heavy snow, ashfall, high wind, etc., cause shielding structure failure and subsequent ion exchanger breach	Internal contamination of ion exchanger	Radioactive release to the environment	None	None	S1	F1	E1	S1 based on results of radiation survey that showed dose rates very near background levels for resin tank. F1 based on open top design of resin tank shielding structure limiting potential loading.
AXIX-02	241-AX-IX ion exchanger structure	Release of contamination from the ion exchanger to the environment due to flooding	Snow melt, heavy rain	Internal contamination of ion exchanger	Contamination release to the environment	None	None	S0	F3	E0	S0 assuming that the structure does not fall over. The resin tank shielding structure is open at the top and bottom. Flooding would have to be very extensive to cause structure to tip over.
AXIX-03	241-AX-IX ion exchanger structure	Release of radioactive aerosols from the ion exchanger to the environment due to flammable gas deflagration in ion exchanger tank	Internal flammable gas generation (with ignition source, e.g., intrusive activities, present)	Contamination contained on resin	Energetic radioactive material release into atmosphere	None	Flam Gas Mon Cntrls Ign Cntrls	S1	F3	E1	F3 based on no controls (consistent with flammable gas assumptions in Authorization Basis). S1 based on results of radiation survey that showed dose rates very near background levels for resin vessel.

Table B-1c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
C801-01a	241-C-801 Cesium Loadout Facility structure	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of structural integrity caused by earthquake	Earthquake (not seismically qualified)	Building and internal (piping) contamination	Radioactive contamination release to the environment	None	None	S1	F2	E1	Seismic events can result in failure of the building.
C801-01b	241-C-801 Cesium Loadout Facility structure	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of building structural integrity caused by aging	Building structure degradation due to age	Building and internal (piping) contamination	Radioactive contamination release to the environment	None	None	S1	F2	E1	Building degradation can result in failure of the building. This event is unlikely for this type of facility.
C801-01c	241-C-801 Cesium Loadout Facility structure	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event)	Building and internal (piping) contamination	Radioactive contamination release to the environment	None	None	S1	F2	E1	F2 based on low likelihood that vehicle can attain sufficient velocity to cause sufficient damage to the building to result in contamination release.

Table B-1c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
C801-01d	241-C-801 Cesium Loadout Facility structure	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of building structural integrity caused by structural overload	Heavy snow, ashfall, high wind, overloading the building roof or walls	Building and internal (piping) contamination	Radioactive release to the environment	None	None	S1	F2	E1	F2 based on low likelihood of sufficient snow, ash, or high wind causing damage to the facility.
C801-02	241-C-801 Cesium Loadout Facility structure	Release of contamination from the 241-C-801 building to the environment due to flooding	Snow melt, heavy rain flood the building	Building and internal (piping) contamination	Contamination release from the building to the environment	Floor drain goes to French drain	None	S0	F3	E1	F3 based on the roof leaking. The environmental release is not permitted by the current *Washington Administrative Codes*. There is currently no raw waster supply to the tank farm so no raw water flooding event was postulated.

Table B-1c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
C801-03a	241-C-801 Cesium Loadout Facility piping	Release of radioactive material from 241-C-801 facility piping to the building due to flammable gas deflagration in piping	Flammable gas intrusion from 241-C-103	Contamination in piping and residual material in the building	Energetic release into building atmosphere (building structure not assumed to be damaged by deflagration)	None	Flam Gas Mon Cntrls Ign Cntrls	S1	F1	E1	F1 based on facility not being gas tight. Gas that intrudes into the facility will diffuse out of the building. If gas is retained only in piping, the diffusion rate would be very low and the concentration would be in equilibrium with the tank headspace, which is assumed to be below flammable limits. S1 based on the potential facility worker harm from the explosion.
C801-03b	241-C-801 Cesium Loadout Facility piping	Release of radioactive material from the facility piping to the building due to flammable gas deflagration in piping	Internal flammable gas generation in piping (with ignition source, e.g., intrusive activities, present)	Contamination in piping and residual material in the building	Energetic release into building atmosphere (building structure not assumed to be damaged by deflagration)	None	Flam Gas Mon Cntrls Ign Cntrls	S1	F1	E1	F1 based on insufficient material to produce flammable gas. S1 based on the potential facility worker harm from the explosion.
C801-04	241-C-801 Cesium Loadout Facility piping	Release of radioactive material from the raw water spray system piping to the building due to flammable gas deflagration in piping	Flammable gas collection in raw water spray system in valve pit (with ignition source, e.g., intrusive activities, present)	Contamination in piping (assuming there is some contamination in the raw water spray system)	Worker harm from flammable gas deflagration	None	None	S1	F2	E0	F2 based on necessity of hydrogen migrating from source into the raw water spray system (torturous path). Hydrogen would tend to be released from the pit rather than be released from the spray system.

Table B-1c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
C801-05a	241-C-801 Cesium Loadout Facility control room	Personnel injury due to release of high pressurized helium	Human error while disconnecting bottles	None	Worker injury	None	Operator Training and Procedures	S1	F3	E0	This is an occupational safety hazard.
C801-05b	241-C-801 Cesium Loadout Facility control room	Personnel injury due to release of high pressurized helium	Impact that breaks the connections on the bottles	None	Worker injury	None	Operator Training and Procedures	S1	F2	E0	This is an occupational safety hazard.
C801-06	241-C-801 Cesium Loadout Facility cask room	Release of radioactive material from tank 241-C-103 to the building (with potential for release to the environment) due to inadvertent start of pump in pit 241-CR-03A (tank 241-C-103)	Human error causes misroute	Tank waste in 241-C-103	Liquid waste spill to floor of facility Potential aerosol release from the facility	None	Operator Training and Procedures Admin Pump Lock out Trans Cntrls	S2	F0	E2	F0 based on the assumption that the pump is INACTIVE and isolated.

Table B-1d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
ITS1-01	ITS1 de-entrainer	Release of asbestos from pipe and tank insulation to the atmosphere due to sampling or maintenance activities	Mechanical disruption of asbestos High winds	Asbestos coating on the pipes and tanks	Facility worker exposure to asbestos	Pink paint	Operator training and procedures	S1	F3	E1	Other asbestos hazards are present in this facility, but the hazards are not any different than this event. This is an occupational safety hazard.
ITS1-02a	ITS1 de-entrainer	Release of contamination from the ITS1 equipment to the atmosphere due to seismic event	Seismic event causes rupture of piping or tanks	Internal contamination of the piping or the tank	Spread of contamination	None	None	S1	F3	E1	The de-entrainer is not seismically qualified and is therefore assigned an F3 frequency.
ITS1-02b	ITS1 de-entrainer	Release of contamination from ITS1 equipment to the atmosphere due to wind-driven missile	Wind-driven missile	Internal contamination of the piping or the tank	Spread of contamination	None	None	S1	F3	E1	Wind-driven missile can be caused by Hanford Site wind and is therefore assigned an F3 frequency.
ITS1-02c	ITS1 de-entrainer	Release of contamination from the ITS1 de-entrainment tank to the atmosphere due to vehicle impact with ITS1	Vehicle impact with ITS1 de-entrainment tank	Internal contamination of the piping or the tank	Spread of contamination	None	None	S1	F3	E1	--
ITS1-03a	ITS1 de-entrainer, condenser, de-mister cyclone, condensate catch tank, filter, ion exchange column	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration in the de-entrainer (with ignition source present)	Sampling activities in de-entrainer and flammable gas produced by radiolysis	Internal contamination of the piping or the tank	This is a high-energy release of radioactive particulates to atmosphere	None	Ign Cntrls Flam Gas Mon Cntrls	S2	F3	E2	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 216-BY-101, 241-BY-102 drain connection.

Table B-1d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
ITS1-03b	ITS1 de-entrainer, condenser, de-mister cyclone, condensate catch tank, filter, ion exchange column	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Vehicle impact with ITS1 equipment and flammable gas produced by radiolysis ignited by impact	Internal contamination of the piping or the tank	This is a high-energy release of radioactive particulates to atmosphere	None	Vehicle Access Cntrls	S2	F2	E2	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 241-BY-101, 241-BY-102 drain connection.
ITS1-03c	ITS1 de-entrainer, condenser, de-mister cyclone, condensate catch tank, filter, ion exchange column	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Lightning strike on ITS1 equipment and flammable gas produced by radiolysis ignited	Internal contamination of the piping or the tank	This is a high-energy release of radioactive particulates to atmosphere	None	Emergency Preparedness	S2	F2	E2	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 241-BY-101, 241-BY-102 drain connection.
ITS1-04	ITS1 (global) low temp/freezing	Release of radioactive contamination from ITS1 equipment to environment from vessels and piping breaches caused by freezing	Low ambient temperature freezes liquids in piping or vessels	Contamination in vessels and piping	Release of contamination from facility vessels and piping	None	None	S0	F0	E0	Based on 26 years of experience, low temperature and freezing are not considered problems for this facility. There is insufficient water in the vessels and piping to cause freeze-related breaks.

Table B-1d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
ITS1-05	ITS1 (global)	Release of radioactive material from ITS1 equipment to environment due to backflow from other facilities	Human error in transfer route setup sends waste to ITS1 facility	Material from other facilities	Flow of waste to environment	None	None	S0	F0	E0	F0 because this facility is not hooked up to any other facilities in a way that could cause backflow. This hazardous condition is included in the preliminary hazards analysis for demonstration of completeness.
ITS1-06a	ITS1 (global)	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Tumbleweed fire close to ITS1 facility causes release of radioactive contamination	Internal contamination of the piping or the tank	Potential for very minor release of radioactive contamination	None	None	S0	F0	E0	Fire is not assumed to be of sufficient magnitude to heat and disperse internal contamination.
ITS1-06b	ITS1 (global)	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Vehicle fire close to ITS1 facility causes release of radioactive contamination	Internal contamination of the piping or the tank	Potential for very minor release of radioactive contamination	None	None	S0	F0	E0	Fire is not assumed to be of sufficient magnitude to heat and disperse internal contamination.
ITS1-06c	ITS1 (global)	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Lightning causes fire in combustible material around ITS1 facility causing release of radioactive contamination	Internal contamination of the piping or the tank	Minor spread of contamination	None	None	S0	F0	E0	Fire is not assumed to be of sufficient magnitude to heat and disperse internal contamination.

Table B-1d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Preliminary Hazards Analysis Data. (4 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
ITS1-07	ITS1 (global)	Release of radioactive material from ITS1 equipment to the environment due to leak from vessel or tubing	Corrosion due to age causes leak in ITS1 piping or vessels	Internal contamination of the piping or the tank	Spread of contamination	None	None	S1	F3	E1	Failure of the condenser cooling tubes could result in contamination being released to retention pond (assumes liquid in the condenser and flow path open).
ITS1-08	ITS1 solution holdup tank	Release of ITS1 solution holdup tank contents to the crib due to unplanned pump operation	Human error results in inadvertent start of solution holdup tank pump	Solution holdup tank contents	Pump back to the de-entrainer, which drains back to the holdup tank Addition of material to 241-BY-102 in violation of single-shell tank waste addition rules (Wyden rules) Tank material goes to crib	None	Work Control Program	S1	F0	E1	F0 based on equipment found to be INACTIVE (disconnected).
ITS1-09	Supernate disposal flush tank?	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	This is an inactive miscellaneous underground storage tank and is already covered in the FSAR*
ITS1-10	ITS1 - exhaust fan	Release of radioactive material from ITS1 equipment to the atmosphere due to an inadvertent fan start	Human error results in inadvertent start of exhaust fans with high-efficiency particulate air filter bypass	Internal contamination of exhaust system	Airborne release of contamination	None	Work Control Program	S1	F0	E1	F0 based on equipment found to be INACTIVE (disconnected).

*HNF-SD-WM-SAR-067, 2000, *Tank Waste Remediation System Final Safety Analysis Report*, revision as amended, CH2M HILL Hanford Group, Inc., Richland, Washington.
N/A = not applicable.

Table B-1e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX401-01	241-SX-401/ Control Building	Release of radioactive contamination from Control Building due to catching fire and burning down	Fire caused by electrical shorts or lightning	Internal contamination in the Control Building (minor)	Contamination spread Facility worker smoke inhalation	None	Emergency Prep Fire protection program	S0	F3	E0	Worker safety issue. Contamination levels are believed to be low.
SX401-02a	241-SX-401/ Control Building	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Human error or equipment failure results in vehicle impact damaging building structure sufficiently to cause collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.
SX401-02b	241-SX-401/ Control Building	Release of radioactive material to atmosphere due to loss of structural integrity (building falls down or is knocked down)	High wind stresses exceed building structural capacity resulting in building collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.
SX401-02c	241-SX-401/ Control Building	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Earthquake causes building collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.

Table B-1e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX401-03	241-SX-401/ Control Building	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	None	Personnel injury	None	Health and Safety Program	S1	F3	E0	Worker safety issue.
SX401-04	241-SX-401 main building	Release of contamination from building to environment due to flooding (roof leaks or external source of water)	Heavy rain or snow melt flood building Accidental connection of raw water to building floods building	Internal contamination in the building	Release of contamination to the environment	Raw water flow totalizers 7 ft of building are below grade	Raw water isolation program	S1	F2	E1	It is difficult to connect raw water to the building. There is no raw water in the SX Tank Farm.
SX401-05	241-SX-401 main building	Release of contamination from 241-SX-401 piping and vessels into building due to pipe rupture from snow melt and subsequent freezing	Snow melt and freeze cycle rupture facility piping or vessels	Internal contamination in the pipes and vessels	Release of contamination to the building (and perhaps environment if flooding sufficient)	7 ft of building are below grade	None	S1	F2	E1	The freeze cycle would be unusual for this area's climate. The building is 7 ft below grade, which will tend to inhibit freezing.
SX401-06a	241-SX-401 main building	Release of contamination from 241-SX-401 facility to environment due to earthquake-caused structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F3	E1	Facility is not seismically qualified so frequency is based on small magnitude earthquake. Also has potential for severing the vapor header and degrading SST ventilation.

Table B-1e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX401-06b	241-SX-401 main building	Release of contamination from 241-SX-401 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F3	E1	Also has potential for severing the vapor header and degrading SST ventilation.
SX401-07	241-SX-401 main building	Condenser support fails and severs the vapor header causing SX Tank Farm ventilation degradation/loss	Earthquake	Internal contamination in the vapor header and building	Degrades ventilation to the SSTs	None	Emergency Prep	S0	F2	E0	Facility is not seismically qualified so frequency is based on moderate magnitude earthquake. Degrades ventilation to the SSTs (same as loss of active ventilation with potential for flammable gas buildup in SSTs). Potential initiator for subsequent flammable gas deflagration.
SX401-08	241-SX-401 main building	Release of contamination to environment from structural failure damaging piping or vessels	High wind/tornado overstresses structure resulting in building collapse and damage to piping and vessels	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F1	E1	F1 is based on concrete structure being resistant to high winds.

Table B-1e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX401-09	241-SX-401 main building	Release of contamination from piping, condenser, or condensate tanks to the environment due to flammable gas deflagration in condenser or condensate tanks	Cutting into condenser or condensate tanks to perform sampling causes sparks PLUS presence of flammable gas (radiolysis or corrosion)	Internal contamination in piping or condenser	Release of contamination to environment as a result of flammable gas deflagration breaching condenser or tanks	None	Ign controls Flammable gas monitoring Training and procedures	S1	F3	E1	F3 based on no controls.
SX401-10	241-SX-401 main building	Movement of contamination from the condensers to facility piping and the crib due to flooding in crib backing up into facility	Flooding in the crib with sufficient quantity of water to cause backup into facility and displacement of contamination	Internal contamination in the piping or condenser that can be disturbed by backflow	Movement of contamination from one location to another in the piping or condensers	None	None	S0	F0	E0	The location of the crib is ~500 ft from the facility and there are no large water sources near the crib.
SX401-11	241-SX-401 main building	Worker safety concerns related to spiders, snakes, rodents, and bio hazards	Worker comes into contact with insects, snakes, rodents, or bio hazards	None	Personnel injury	None	Health and Safety program	S1	F3	E0	These agents are always present on the Hanford Site. Captured for completeness only.
SX401-12	241-SX-401 sample pit	Minor personnel contamination potential from activities involving the sample pit	Disturbance of contamination in the sample pit due to personnel performing work in the sample pit	Very minor quantities of radioactive contamination in the sample pit	Minor personnel contamination by radioactive material	None	None	S0	F0	E0	No hazards identified outside of personnel safety and minor radioactive material contamination.
SX401-13	241-SX-401 dry well (French drain)	Movement of contamination in soil surrounding dry well due to flooding drain	Rain or snow melt of sufficient quantity to flood facility drain	Contamination in the soil surrounding the dry well	Movement of contamination in local area	None	None	S0	F1	E1	The source term for this event is very small.

Table B-1e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX401-14	241-SX-106 condensate pump pit	Release of radioactive material from tank 241-SX-106 to soil subsurface as a result of pumping tank waste into condenser head tank due to operation of condensate pump in 241-SX-106	Human error results in start of condensate pump (requires multiple actions to cause this event to occur)	Radioactive waste in tank 241-SX-106	Misrouting of tank waste into the 241-SX-401 piping systems (eventually can get into crib)	Isolation valves (currently inoperable)	Operation procedures	S1	F1	E3	Status of valve position is unknown but valves cannot be operated; valve handles also have been removed. The condensate pump is in a weather-sealed pit and has not been operated in a long time. S1 based on potential radiological exposure to worker. F1 based on the assumed condition of the system and pump; requires a lot of work to get the pump to operate. The pump is not hooked up to power.

SST = single-shell tank.

Table B-1f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX402-01	241-SX-402/ Control Building	Release of radioactive contamination from Control Building due to catching fire and burning down	Fire caused by electrical shorts or lightning	Internal contamination in the Control Building (minor)	Contamination spread Facility worker smoke inhalation	None	Emergency Prep Fire protection program	S0	F3	E0	Worker safety issue. Contamination levels are believed to be low.
SX402-02a	241-SX-402/ Control Building	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Human error or equipment failure results in vehicle impact damaging building structure sufficiently to cause collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.
SX402-02b	241-SX-402/ Control Building	Release of radioactive material to atmosphere due to loss of structural integrity (building falls down or is knocked down)	High wind stresses exceed building structural capacity resulting in building collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.
SX402-02c	241-SX-402/ Control Building	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Earthquake causes building collapse	Internal contamination in the Control Building (minor)	Contamination spread	None	Emergency prep	S0	F3	E0	Contamination levels are believed to be low.

Table B-1f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX402-03	241-SX-402/ Control Building	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	None	Personnel injury	None	Health and Safety Program	S1	F3	E0	Worker safety issue.
SX402-04	241-SX-402 main building	Release of contamination from building to environment due to flooding (roof leaks or external source of water)	Heavy rain or snow melt flood building Accidental connection of raw water to building floods building	Internal contamination in the building	Release of contamination to the environment	Raw water flow totalizers 7 ft of building are below grade	Raw water isolation program	S1	F2	E1	It is difficult to connect raw water to the building. There is no raw water in the SX Tank Farm.
SX402-05	241-SX-402 main building	Release of contamination from 241-SX-402 piping and vessels into building due to pipe rupture from snow melt and subsequent freezing	Snow melt and freeze cycle rupture facility piping or vessels	Internal contamination in the pipes and tanks	Release of contamination to the building (and perhaps environment if flooding sufficient)	7 ft of building are below grade	None	S1	F2	E1	The freeze cycle would be unusual for this area's climate. The building is 7 ft below grade, which will tend to inhibit freezing.
SX402-06a	241-SX-402 main building	Release of contamination from 241-SX-402 facility to environment due to earthquake-cause d structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F3	E1	Facility is not seismically qualified so frequency is based on small magnitude earthquake. Also has potential for severing the vapor header and degrading SST ventilation.

Table B-1f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX402-06b	241-SX-402 main building	Release of contamination from 241-SX-402 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F3	E1	Also has potential for severing the vapor header and degrading SST ventilation.
SX402-07	241-SX-402 main building	Condenser support fails and severs the vapor header causing SX Tank Farm ventilation degradation/loss	Earthquake	Internal contamination in the vapor header and building	Degrades ventilation to the SSTs	None	Emergency Prep	S0	F2	E0	Facility is not seismically qualified so frequency is based on moderate magnitude earthquake. Degrades ventilation to the SSTs (same as loss of active ventilation with potential for flammable gas buildup in SSTs). Potential initiator for subsequent flammable gas deflagration.
SX402-08	241-SX-402 main building	Release of contamination to environment from structural failure damaging piping or vessels	High wind/tornado overstresses structure resulting in building collapse and damage to piping and vessels	Internal contamination in the pipes, vessels, and building	Release of contamination to environment	None	Emergency Prep	S1	F1	E1	F1 is based on concrete structure being resistant to high winds.

Table B-1f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX402-09	241-SX-402 main building	Release of contamination from piping, condenser, or condensate tanks to the environment due to flammable gas deflagration in condenser or condensate tanks	Cutting into condenser or condensate tanks to perform sampling causes sparks PLUS presence of flammable gas (radiolysis or corrosion)	Internal contamination in piping or condenser	Release of contamination to environment as a result of flammable gas deflagration breaching condenser or tanks	None	Ign controls Flammable gas monitoring Training and procedures	S1	F3	E1	F3 based on no controls.
SX402-10	241-SX-402 main building	Movement of contamination from the condensers to facility piping and the crib due to flooding in crib backing up into facility	Flooding in the crib with sufficient quantity of water to cause backup into facility and displacement of contamination	Internal contamination in the piping or condenser that can be disturbed by backflow	Movement of contamination from one location to another in the piping or condensers	None	None	S0	F0	E0	The location of the crib is ~500 ft from the facility and there are no large water sources near the crib.
SX402-11	241-SX-402 main building	Worker safety concerns related to spiders, snakes, rodents, and bio hazards	Worker comes into contact with insects, snakes, rodents, or bio hazards	None	Personnel injury	None	Health and Safety program	S1	F3	E0	These agents are always present on the Hanford Site. Captured for completeness only.
SX402-12	241-SX-402 sample pit	Minor personnel contamination potential from activities involving the sample pit	Disturbance of contamination in the sample pit due to personnel performing work in the sample pit	Very minor quantities of radioactive contamination in the sample pit	Minor personnel contamination by radioactive material	None	None	S0	F0	E0	No hazards identified outside of personnel safety and minor radioactive material contamination.
SX402-13	241-SX-402 dry well (French drain)	Movement of contamination in soil surrounding dry well due to flooding drain	Rain or snow melt of sufficient quantity to flood facility drain	Contamination in the soil surrounding the dry well	Movement of contamination in local area	None	None	S0	F1	E1	The source term for this event is very small.

Table B-1f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Preliminary Hazards Analysis Data. (5 sheets)

ID	Location/ Activity	Hazardous Condition	Candidate Cause	Material at Risk	Consequence	Suggested SSCs	Suggested TSRs	Cons Cat	Freq Cat	Env Cat	Remarks
SX402-14	241-SX-112 condensate pump pit	Release of radioactive material from tank 241-SX-112 to soil subsurface as a result of pumping tank waste into condenser head tank due to operation of condensate pump in 241-SX-112	Human error results in start of condensate pump (requires multiple actions to cause this event to occur)	Radioactive waste in tank 241-SX-112	Misrouting of tank waste into the 241-SX-402 piping systems (eventually can get into crib)	Isolation valves (currently inoperable)	Operation procedures	S1	F1	E3	Status of valve position is unknown but valves cannot be operated; valve handles also have been removed. The condensate pump is in a weather-sealed pit and has not been operated in a long time. S1 based on potential radiological exposure to worker. F1 based on the understood condition of the system and pump; requires a lot of work to get the pump to operate.

SST = single-shell tank.

Table B-2a. 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions with Potentially Significant Onsite Worker Consequences (S2).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
A431-01a1	Release of radioactive contamination to the environment due to collapse of building structure caused by earthquake	Earthquake causes building structural failure (building and equipment not seismically qualified)	F2	E2
A431-01b1	Release of radioactive contamination from facility to the environment due to building collapse caused by loss of structural integrity caused by aging	Building structure degradation and failure due to aging	F2	E2
A431-01c	Release of radioactive material to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event) caused by operator error or equipment failure	F0	E2
A431-01d	Release of radioactive material to the environment due to loss of structural integrity caused by structural overload	Heavy snow, ashfall, high wind, etc., exceed structure load capacity	F1	E2
A431-04	Release of radioactive aerosols to the environment due to hydrogen generation and ignition within the de-entrainer	Potential flammable gas migration from A Tank Farm or generation within the de-entrainer (with ignition source, e.g., sampling activities, lightning, present)	F0	E2

Table B-2b. 241-C-801 Cesium Loadout Facility (C Tank Farm) Hazardous Conditions with Potentially Significant Onsite Worker Consequences (S2).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
C801-06	Release of radioactive material from tank 241-C-103 to the building (with potential for release to the environment) due to inadvertent start of pump in pit 241-CR-03A (tank 241-C-103)	Human error causes misroute	F0	E2

Table B-2c. ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions with Potentially Significant Onsite Worker Consequences (S2).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
ITS1-03a	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration in the de-entrainer (with ignition source present)	Sampling activities in de-entrainer and flammable gas produced by radiolysis	F3	E2
ITS1-03b	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Vehicle impact with ITS1 equipment and flammable gas produced by radiolysis ignited by impact	F2	E2
ITS1-03c	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Lightning strike on ITS1 equipment and flammable gas produced by radiolysis ignited	F2	E2

Table B-3a. 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
A431-01a2	Release of radioactive contamination to the building due to breach of de-entrainer caused by earthquake	Earthquake causes de-entrainer breach (equipment not seismically qualified)	F3	E1
A431-01b2	Release of radioactive contamination from de-entrainer to the building due to loss of de-entrainer support structure integrity caused by aging	De-entrainer support structure degradation and subsequent failure due to aging effects	F3	E1
A431-06	Release of radioactive material to the environment due to A Tank Farm pressurization of 241-A-431 vapor header	The vapor header in communication with the A Tank Farm tanks experiences headspace pressurization	F0	E1
A431-07	Release of radioactive material to the environment due to inadvertent start of the vent fans	Human error results in startup of vent fans	F1	E1

Table B-3b. 241-AX-IX Ion Exchanger (AX Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
AXIX-01a	Release of radioactive materials to the environment due to shielding collapse and resin tank breach caused by earthquake	Earthquake (equipment not seismically qualified) causes shielding structure collapse with resulting breach of resin tank	F2	E1
AXIX-01b	Release of radioactive materials from the resin tank to the environment due to shielding structure collapse caused by structural degradation from aging	Shielding structure collapse and resin tank rupture caused by age-related degradation	F2	E1
AXIX-01c	Release of radioactive materials from the resin tank to the environment due to resin tank breach caused by failure of shielding structure from vehicle impact	Vehicle impact (this is an unlikely event) with shielding structure results in structure failure and resin tank breach	F2	E1
AXIX-01d	Release of radioactive materials from the ion exchanger to the environment due to breach of resin tank caused by shielding structure overload caused failure	Heavy snow, ashfall, high wind, etc., cause shielding structure failure and subsequent ion exchanger breach	F1	E1
AXIX-03	Release of radioactive aerosols from the ion exchanger to the environment due to flammable gas deflagration in ion exchanger tank	Internal flammable gas generation (with ignition source, e.g., intrusive activities, present)	F3	E1

Table B-3c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
C801-01a	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of structural integrity caused by earthquake	Earthquake (not seismically qualified)	F2	E1
C801-01b	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of building structural integrity caused by aging	Building structure degradation due to age	F2	E1
C801-01c	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event)	F2	E1
C801-01d	Release of radioactive contamination from the 241-C-801 facility to the environment due to loss of building structural integrity caused by structural overload	Heavy snow, ashfall, and high wind, overloading the building roof or walls	F2	E1
C801-03a	Release of radioactive material from 241-C-801 facility piping to the building due to flammable gas deflagration in piping	Flammable gas intrusion from 241-C-103	F1	E1
C801-03b	Release of radioactive material from the facility piping to the building due to flammable gas deflagration in piping	Internal flammable gas generation in piping (with ignition source, e.g., intrusive activities, present)	F1	E1
C801-04	Release of radioactive material from the raw water spray system piping to the building due to flammable gas deflagration in piping	Flammable gas collection in raw water spray system in valve pit (with ignition source, e.g., intrusive activities, present)	F2	E0
C801-05a	Personnel injury due to release of high pressurized helium	Human error while disconnecting bottles	F3	E0
C801-05b	Personnel injury due to release of high pressurized helium	Impact that breaks the connections on the bottles	F2	E0

Table B-3d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
ITS1-01	Release of asbestos from pipe and tank insulation to the atmosphere due to sampling or maintenance activities	Mechanical disruption of asbestos High winds	F3	E1
ITS1-02a	Release of contamination from the ITS1 equipment to the atmosphere due to seismic event	Seismic event causes rupture of piping or tanks	F3	E1
ITS1-02b	Release of contamination from ITS1 equipment to the atmosphere due to wind-driven missile	Wind-driven missile	F3	E1
ITS1-02c	Release of contamination from the ITS1 de-entrainment tank to the atmosphere due to vehicle impact with ITS1	Vehicle impact with ITS1 de-entrainment tank	F3	E1
ITS1-07	Release of radioactive material from ITS1 equipment to the environment due to leak from vessel or tubing	Corrosion due to age causes leak in ITS1 piping or vessels	F3	E1
ITS1-08	Release of ITS1 solution holdup tank contents to the crib due to unplanned pump operation	Human error results in inadvertent start of solution holdup tank pump	F0	E1
ITS1-10	Release of radioactive material from ITS1 equipment to the atmosphere due to an inadvertent fan start	Human error results in inadvertent start of exhaust fans with high-efficiency particulate air filter bypass	F0	E1

Table B-3e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
SX401-03	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	F3	E0
SX401-04	Release of contamination from building to environment due to flooding (roof leaks or external source of water)	Heavy rain or snow melt flood building Accidental connection of raw water to building floods building	F2	E1
SX401-05	Release of contamination from 241-SX-401 piping and vessels into building due to pipe rupture from snow melt and subsequent freezing	Snow melt and freeze cycle rupture facility piping or vessels	F2	E1
SX401-06a	Release of contamination from 241-SX-401 facility to environment due to earthquake-caused structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	F3	E1
SX401-06b	Release of contamination from 241-SX-401 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	F3	E1
SX401-08	Release of contamination to environment from structural failure damaging piping or vessels	High wind/tornado overstresses structure resulting in building collapse and damage to piping and vessels	F1	E1
SX401-09	Release of contamination from piping, condenser, or condensate tanks to the environment due to flammable gas deflagration in condenser or condensate tanks	Cutting into condenser or condensate tanks to perform sampling causes sparks PLUS presence of flammable gas (radiolysis or corrosion)	F3	E1
SX401-11	Worker safety concerns related to spiders, snakes, rodents, and bio hazards	Worker comes into contact with insects, snakes, rodents, or bio hazards	F3	E0
SX401-14	Release of radioactive material from tank 241-SX-106 to soil subsurface as a result of pumping tank waste into condenser head tank due to operation of condensate pump in 241-SX-106	Human error results in start of condensate pump (requires multiple actions to cause this event to occur)	F1	E3

Table B-3f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions with Potentially Significant Facility Worker Consequences (S1).

ID	Hazardous Condition	Candidate Cause	Freq Cat	Env Cat
SX402-03	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	F3	E0
SX402-04	Release of contamination from building to environment due to flooding (roof leaks or external source of water)	Heavy rain or snow melt flood building Accidental connection of raw water to building floods building	F2	E1
SX402-05	Release of contamination from 241-SX-402 piping and vessels into building due to pipe rupture from snow melt and subsequent freezing	Snow melt and freeze cycle rupture facility piping or vessels	F2	E1
SX402-06a	Release of contamination from 241-SX-402 facility to environment due to earthquake-caused structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	F3	E1
SX402-06b	Release of contamination from 241-SX-402 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	F3	E1
SX402-08	Release of contamination to environment from structural failure damaging piping or vessels	High wind/tornado overstresses structure resulting in building collapse and damage to piping and vessels	F1	E1
SX402-09	Release of contamination from piping, condenser, or condensate tanks to the environment due to flammable gas deflagration in condenser or condensate tanks	Cutting into condenser or condensate tanks to perform sampling causes sparks PLUS presence of flammable gas (radiolysis or corrosion)	F3	E1
SX402-11	Worker safety concerns related to spiders, snakes, rodents, and bio hazards	Worker comes into contact with insects, snakes, rodents, or bio hazards	F3	E0
SX402-14	Release of radioactive material from tank 241-SX-112 to soil subsurface as a result of pumping tank waste into condenser head tank due to operation of condensate pump in 241-SX-112	Human error results in start of condensate pump (requires multiple actions to cause this event to occur)	F1	E3

Table B-4a. 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions with no Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
A431-02	Release of contamination from building to the environment due to flooding	Snow melt, heavy rain flood the building sufficiently to move contamination outside the building	F3	E1
A431-03a	Release of radioactive contamination to the environment due to loss of leak from the de-entrainer	Structural degradation due to corrosion results in leak of contamination	F3	E1
A431-03b	Release of radioactive material to the environment due to loss of structural integrity of the de-entrainer	Failure of supporting structures causes breach in de-entrainer and release of contamination	F3	E1
A431-05	Release of radioactive material to the environment due to backflow through 1-in. drain to 8-in. vent	Backup of drain due to external causes outside of 241-A-431 disturbs contamination in de-entrainer	F2	E1
A431-08	Release of radioactive material to the environment due to inadvertent start of the roof ventilator	Human error results in startup of roof ventilator	F1	E0

Table B-4b. 241-AX-IX Ion Exchanger (AX Tank Farm) Hazardous Conditions with No Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
AXIX-02	Release of contamination from the ion exchanger to the environment due to flooding	Snow melt, heavy rain	F3	E0

Table B-4c. 241-C-801 Cesium Loadout Facility (C Tank Farm) Hazardous Conditions with No Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
C801-02	Release of contamination from the 241-C-801 building to the environment due to flooding	Snow melt, heavy rain flood the building	F3	E1

Table B-4d. ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions with no Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
ITS1-04	Release of radioactive contamination from ITS1 equipment to environment from vessels and piping breaches caused by freezing	Low ambient temperature freezes liquids in piping or vessels	F0	E0
ITS1-05	Release of radioactive material from ITS1 equipment to environment due to backflow from other facilities	Human error in transfer route setup sends waste to ITS1 facility	F0	E0
ITS1-06a	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Tumbleweed fire close to ITS1 facility causes release of radioactive contamination	F0	E0
ITS1-06b	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Vehicle fire close to ITS1 facility causes release of radioactive contamination	F0	E0
ITS1-06c	Release of radioactive contamination from ITS1 equipment to the environment due to high temperatures around contaminated piping and tank	Lightning causes fire in combustible material around ITS1 facility causing release of radioactive contamination	F0	E0

Table B-4e. 241-SX-401 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions with no Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
SX401-01	Release of radioactive contamination from Control Building due to catching fire and burning down	Fire caused by electrical shorts or lightning	F3	E0
SX401-02a	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Human error or equipment failure results in vehicle impact damaging building structure sufficiently to cause collapse	F3	E0
SX401-02b	Release of radioactive material to atmosphere due to loss of structural integrity (building falls down or is knocked down)	High wind stresses exceed building structural capacity resulting in building collapse	F3	E0
SX401-02c	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Earthquake causes building collapse	F3	E0
SX401-07	Condenser support fails and severs the vapor header causing SX Tank Farm ventilation degradation/loss	Earthquake	F2	E0
SX401-10	Movement of contamination from the condensers to facility piping and the crib due to flooding in crib backing up into facility	Flooding in the crib with sufficient quantity of water to cause backup into facility and displacement of contamination	F0	E0
SX401-12	Minor personnel contamination potential from activities involving the sample pit	Disturbance of contamination in the sample pit due to personnel performing work in the sample pit	F0	E0
SX401-13	Movement of contamination in soil surrounding dry well due to flooding drain	Rain or snow melt of sufficient quantity to flood facility drain	F1	E1

Table B-4f. 241-SX-402 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions with no Significant Consequences (S0).

ID	Hazardous Condition	Cause	Freq Cat	Env Cat
SX402-01	Release of radioactive contamination from Control Building due to catching fire and burning down	Fire caused by electrical shorts or lightning	F3	E0
SX402-02a	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Human error or equipment failure results in vehicle impact damaging building structure sufficiently to cause collapse	F3	E0
SX402-02b	Release of radioactive material to atmosphere due to loss of structural integrity (building falls down or is knocked down)	High wind stresses exceed building structural capacity resulting in building collapse	F3	E0
SX402-02c	Release of radioactive contamination from Control Building to atmosphere due to loss of structural integrity (building falls down or is knocked down)	Earthquake causes building collapse	F3	E0
SX402-07	Condenser support fails and severs the vapor header causing SX Tank Farm ventilation degradation/loss	Earthquake	F2	E0
SX402-10	Movement of contamination from the condensers to facility piping and the crib due to flooding in crib backing up into facility	Flooding in the crib with sufficient quantity of water to cause backup into facility and displacement of contamination	F0	E0
SX402-12	Minor personnel contamination potential from activities involving the sample pit	Disturbance of contamination in the sample pit due to personnel performing work in the sample pit	F0	E0
SX402-13	Movement of contamination in soil surrounding dry well due to flooding drain	Rain or snow melt of sufficient quantity to flood facility drain	F1	E1

Table B-5a. Analyzed Accidents and Represented Hazardous Conditions for 241-A-431 Ventilation Building (A Tank Farm).

BIN	ID	Material at Risk	Hazardous Condition	Candidate Cause	Freq Cat	Cons Cat	Cause Grp	Rep Acc
Analyzed Accident: Flammable Gas Deflagrations - SST (Rep Acc 05)								
A-1-a	XS-01-FLO W03	SST and DCRT contents	Release of liquids, solids and/or vapors from SST due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to SST	Pipeline connecting SST and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	05
Flammable Gas Deflagrations - SST Represented Hazardous Conditions								
A-1-a	A431-04	Residue on the de-entrainer	Release of radioactive aerosols to the environment due to hydrogen generation and ignition within the de-entrainer	Potential flammable gas migration from A Tank Farm or generation within the de-entrainer (with ignition source, e.g., sampling activities, lightning, present)	F0	S2	B08	05X
Analyzed Accident: Aboveground Tank Failure due to Excessive Loads (Rep Acc 34)								
B-1-a	242T-03	Loading of tanks in 242-T Evaporator Building based on maximum radioactive material allowed in evaporator vessel with 15 years of decay - 7662.7 Ci	Release of radioactive particulates from a 242-T Evaporator Building process tank to atmosphere due to tank breach caused by falling roof panel	Seismic event causes panel to fall	F2	S2	D18	34
Aboveground Tank Failure due to Excessive Loads Represented Hazardous Conditions								
B-1-a	A431-01a1	Building and internal (de-entrainer and piping) contamination	Release of radioactive contamination to the environment due to collapse of building structure caused by earthquake	Earthquake causes building structural failure (building and equipment not seismically qualified)	F2	S2	D18	34X
B-1-a	A431-01b1	Building and internal (de-entrainer and piping) contamination	Release of radioactive contamination from facility to the environment due to building collapse caused by loss of structural integrity caused by aging	Building structure degradation and failure due to aging	F2	S2	D12	34X
B-1-a	A431-01c	Building and internal (de-entrainer and piping) contamination	Release of radioactive material to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event) caused by operator error or equipment failure	F0	S2	E25	34X
B-1-a	A431-01d	Building and internal (de-entrainer and piping) contamination	Release of radioactive material to the environment due to loss of structural integrity caused by structural overload	Heavy snow, ashfall, high wind, etc., exceed structure load capacity	F1	S2	D20	34X

DCRT = double-contained receiver tank.
SST = single-shell tank.

Table B-5b. Analyzed Accidents and Represented Hazardous Conditions for 241-C-801 Cesium Loadout Facility (C Tank Farm).

BIN	ID	Material at Risk	Hazardous Condition	Candidate Cause	Freq Cat	Cons Cat	Cause Grp	Rep Acc
Analyzed Accident: Spray Leak in Structure or from Over ground Waste Transfer Lines (Rep Acc 15)								
B-1-a	XS-06-FLO W02	DCRT waste being transferred to tank 241-SY-102	Release of liquid radioactive waste from DCRT transfer piping to tank 241-SY-102 due to spray leak in DCRT pump pit	Pipe failure in DCRT pump pit causing spray leak	F2	S3	D12	15
Spray Leak in Structure or from Over ground Waste Transfer Lines Represented Hazardous Conditions								
B-1-a	C801-06	Tank waste in 241-C-103	Release of radioactive material from tank 241-C-103 to the building (with potential for release to the environment) due to inadvertent start of pump in pit 241-CR-03A (tank 241-C-103)	Human error causes misroute	F0	S2	E05	15X

DCRT = double-contained receiver tank.

Table B-5c. Analyzed Accidents and Represented Hazardous Conditions for ITS1 In-Tank Solidification Facility (BY Tank Farm).

BIN	ID	Material at Risk	Hazardous Condition	Candidate Cause	Freq Cat	Cons Cat	Cause Grp	Rep Acc
Analyzed Accident: Flammable Gas Deflagrations - SST (Rep Acc 05)								
A-1-a	XS-01-FLO W03	SST and DCRT contents	Release of liquids, solids, and/or vapors from SST due to dome collapse and DCRT pressurization caused by flammable gas fire/explosion propagating from DCRT to SST	Pipeline connecting SST and DCRT fills with flammable gas; loss of ventilation flow in DCRT so that a flammable gas atmosphere is ignited by the ventilation outlet heater	F2	S3	B07	05
Flammable Gas Deflagrations - SST Represented Hazardous Conditions								
A-1-a	ITS1-03a	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration in the de-entrainer (with ignition source present)	Sampling activities in de-entrainer and flammable gas produced by radiolysis	F3	S2	B08	05X
A-1-a	ITS1-03b	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Vehicle impact with ITS1 equipment and flammable gas produced by radiolysis ignited by impact	F2	S2	B25	05X
A-1-a	ITS1-03c	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Lightning strike on ITS1 equipment and flammable gas produced by radiolysis ignited	F2	S2	B21	05X

DCRT = double-contained receiver tank.
SST = single-shell tank.

Table B-6a. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Analyzed Accident: Flammable Gas Deflagration - SST (Rep Acc 05)									
A431-04	Residue on the de-entrainer	Release of radioactive aerosols to the environment due to hydrogen generation and ignition within the de-entrainer	Potential flammable gas migration from A Tank Farm or generation within the de-entrainer (with ignition source, e.g., sampling activities, lightning, present)	None required	None required	None required	None required	No controls required based on low accident frequency	S2 based on uncertainty of quantity of material and hydrogen gas presence. F0 based on no potential mechanism for hydrogen generation.
Analyzed Accident: (Rep Acc 34)									
A431-01a1	Building and internal (de-entrainer and piping) contamina-ti on	Release of radioactive contamination to the environment due to collapse of building structure caused by earthquake	Earthquake causes building structural failure (building and equipment not seismically qualified)	None required	None required	None required	AC: Emergency Response (Seismic)	Controls based on Analyzed Accident (Natural Phenomena - Seismic)	Seismic events can result in failure of the building, but the frequency is unlikely based on poured concrete construction.
A431-01b1	Building and internal (de-entrainer and piping) contamina-ti on	Release of radioactive contamination from facility to the environment due to building collapse caused by loss of structural integrity caused by aging	Building structure degradation and failure due to aging	None required	None required	None required	None required	No controls required based on S2-F2 Authorization Basis criteria for control application	Building structural degradation can result in failure of the building, but this event is unlikely for this type of facility.

Table B-6a. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
A431-01c	Building and internal (de-entrainer and piping) contamina-ti on	Release of radioactive material to the environment due to loss of structural integrity caused by vehicle impact	Vehicle impact (this is an unlikely event) caused by operator error or equipment failure	None required	None required	None required	None required	No controls required based on low event frequency	The facility construction resembles a "pill box" and consists of poured concrete. Extreme vehicle velocities would be required to penetrate the building.
A431-01d	Building and internal (de-entrainer and piping) contamina-ti on	Release of radioactive material to the environment due to loss of structural integrity caused by structural overload	Heavy snow, ashfall, high wind, etc., exceed structure load capacity	None required	None required	None required	AC: Emergency Response	Controls based on Analyzed Accident (Natural Phenomena - High Wind)	None.
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
A431-01a2	Internal (de-entrainer and piping) contamina-ti on	Release of radioactive contamination to the building due to breach of de-entrainer caused by earthquake	Earthquake causes de-entrainer breach (equipment not seismically qualified)	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	De-entrainer structure support structure is not seismically qualified.

Table B-6a. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-A-431 Ventilation Building (A Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
A431-01b2	Internal (de-entrainer and piping) radioactive contamina-tion	Release of radioactive contamination from de-entrainer to the building due to loss of de-entrainer support structure integrity caused by aging	De-entrainer support structure degradation and subsequent failure due to aging effects	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	Support structure degradation can result in failure of the de-entrainer. This event is not unusual for this type of facility.

Table B-6b. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-AX-IX Ion Exchanger (AX Tank Farm) Hazardous Conditions.

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit TSR	Mit SSC	Control MEMO	Remarks
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
AXIX-03	Contamina-tion contained on resin	Release of radioactive aerosols from the ion exchanger to the environment due to flammable gas deflagration in ion exchanger tank	Internal flammable gas generation (with ignition source, e.g., intrusive activities, present)	None	AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/ Measure/Test Equip	AC: Emergency Prep (Fire)	None	Controls based on Authorization Basis Appendix K in the FSAR.*	F3 based on no controls. (consistent with flammable gas assumptions in Authorization Basis) S1 based on results of radiation survey that showed dose rates very near background levels for resin vessel.

*HNF-SD-WM-SAR-067, 2000, *Tank Waste Remediation System Final Safety Analysis Report*, revision as amended, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table B-6c. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-C-801 Cesium Loadout Facility (C Tank Farm) Hazardous Conditions.

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Analyzed Accident: Spray Leak in Structure or from Over ground Waste Transfer Lines (Rep Acc 15)									
C801-06	Tank waste in 241-C-103	Release of radioactive material from tank 241-C-103 to the building (with potential for release to the environment) due to inadvertent start of pump in pit 241-CR-03A (tank 241-C-103)	Human error causes misroute	None required	None required	None required	None required	No controls required based on low accident frequency	F0 based on the assumption that the pump is INACTIVE and isolated. This facility might be physically disconnected and it is unknown if this pump has power. Unknown if pump will work; no maintenance. Unknown if the lines from the pump to the facility are cut and capped in accordance with drawings. If this is found to be true, the frequency decreases to an F0.
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
C801-05a	None	Personnel injury due to release of high pressurized helium	Human error while disconnecting bottles	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Occupational Health and Safety). Safety Management Programs control facility worker exposure to workplace hazards.	This is an occupational safety hazard.

Table B-6d. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Analyzed Accident: Flammable Gas Deflagrations - SST (Rep Acc 05)									
ITS1-03a	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration in the de-entrainer (with ignition source present)	Sampling activities in de-entrainer and flammable gas produced by radiolysis	None required	AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/ Measure/Test Equip	None required	AC: Emergency Prep (Fire)	Controls based on Authorization Basis Appendix K in the FSAR*	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 241-BY-101, 241-BY-102 drain connection.
ITS1-03b	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Vehicle impact with ITS1 equipment and flammable gas produced by radiolysis ignited by impact	None required	None required	None required	AC: Emergency Prep (Fire)	Controls based on Authorization Basis Appendix K in the FSAR*	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 241-BY-101, 241-BY-102 drain connection.
ITS1-03c	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to flammable gas deflagration from the de-entrainer (with ignition source present)	Lightning strike on ITS1 equipment and flammable gas produced by radiolysis ignited	None required	None required	None required	AC: Emergency Prep (Fire)	Controls based on Authorization Basis Appendix K in the FSAR*	S2 based on uncertainty of source term. The design of the solution holdup tank precludes hydrogen buildup. Flammable gas also could come from the 241-BY-101, 241-BY-102 drain connection.

Table B-6d. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
ITS1-01	Asbestos coating on the pipes and tanks	Release of asbestos from pipe and tank insulation to the atmosphere due to sampling or maintenance activities	Mechanical disruption of asbestos High winds	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Occupational Health and Safety). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	There are other asbestos hazards present in this facility, but the hazards are not any different than this event. This is an occupational safety hazard.
ITS1-02a	Internal contamination of the piping or the tank	Release of contamination from the ITS1 equipment to the atmosphere due to seismic event	Seismic event causes rupture of piping or tanks	None	None	None	AC: Emergency Response (Seismic)	Controls based on Analyzed Accident (Natural Phenomena – Seismic)	The de-entrainer is not seismically qualified and is therefore assigned an F3 frequency.
ITS1-02b	Internal contamination of the piping or the tank	Release of contamination from ITS1 equipment to the atmosphere due to wind-driven missile	Wind-driven missile	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	Wind-driven missile can be caused by Hanford Site wind and is therefore assigned an F3 frequency.

Table B-6d. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address ITS1 In-Tank Solidification Facility (BY Tank Farm) Hazardous Conditions. (3 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
ITS1-02c	Internal contamination of the piping or the tank	Release of contamination from the ITS1 de-entrainment tank to the atmosphere due to vehicle impact with ITS1	Vehicle impact with ITS1 de-entrainment tank	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	The de-entrainer is not seismically qualified and is therefore assigned an F3 frequency.
ITS1-07	Internal contamination of the piping or the tank	Release of radioactive material from ITS1 equipment to the environment due to leak from vessel or tubing	Corrosion due to age causes leak in ITS1 piping or vessels	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	Failure of the condenser cooling tubes could result in contamination being released to retention pond (assumes liquid in the condenser and flow path open).

*HNF-SD-WM-SAR-067, 2000, *Tank Waste Remediation System Final Safety Analysis Report*, revision as amended, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table B-6e. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-SX-401 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions. (2 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
SX401-03	None	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Occupational Health and Safety). Safety Management Programs control facility worker exposure to workplace hazards.	Worker safety issue.
SX401-06a	Internal contamination in the pipes, vessels, and building	Release of contamination from 241-SX-401 facility to environment due to earthquake-caused structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	None	None	None	AC: Emergency Response (Seismic)	Controls based on Analyzed Accident (Natural Phenomena – Seismic)	Facility is not seismically qualified so frequency is based on small magnitude earthquake. Also has potential for severing the vapor header and degrading single-shell tank ventilation.
SX401-06b	Internal contamination in the pipes, vessels, and building	Release of contamination from 241-SX-401 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	Also has potential for severing the vapor header and degrading single-shell tank ventilation.

Table B-6f. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-SX-402 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions. (2 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
Hazardous Conditions Assigned S1 Consequence Category and F3 Frequency Category									
SX402-03	None	Worker injury due to contact with energized electrical equipment	Accidental contact by worker with energized wire (building wiring is degraded)	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Occupational Health and Safety). Safety Management Programs control facility worker exposure to workplace hazards.	Worker safety issue.
SX402-06a	Internal contamination in the pipes, vessels, and building	Release of contamination from 241-SX-402 facility to environment due to earthquake-caused structural failure damaging piping or vessels	Earthquake causes structural failure and building collapse	None	None	None	AC: Emergency Response (Seismic)	Controls based on Analyzed Accident (Natural Phenomena - Seismic)	Facility is not seismically qualified so frequency is based on small magnitude earthquake. Also has potential for severing the vapor header and degrading single-shell tank ventilation.
SX402-06b	Internal contamination in the pipes, vessels, and building	Release of contamination from 241-SX-402 facility to environment due to structural failure damaging piping or vessels caused by structural degradation	Building roof degradation and collapse caused by aging damages piping or vessels	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Radiation Protection). Safety Management Programs control facility worker exposure through radiation and toxic material control programs.	Also has potential for severing the vapor header and degrading single-shell tank ventilation.

Table B-6f. Equipment Important to Safety and Controls from the Authorization Basis that Potentially Address 241-SX-402 Condenser Shielding Building (SX Tank Farm) Hazardous Conditions. (2 sheets)

ID	Material at Risk	Hazardous Condition	Candidate Cause	Prev SSC	Prev TSR	Mit SSC	Mit TSR	Control MEMO	Remarks
SX402-09	Internal contamination in piping or condenser	Release of contamination from piping, condenser, or condensate tanks to the environment due to flammable gas deflagration in condenser or condensate tanks	Cutting into condenser or condensate tanks to perform sampling causes sparks PLUS presence of flammable gas (radiolysis or corrosion)	None required	AC: Ign Cntrls (Flam Gas) AC: Flam Gas Mon Cntrls AC: Process Instrument/ Measure/Test Equip	None required	AC: Emergency Prep (Fire)	Controls based on Authorization Basis Appendix K in the FSAR*	F3 based on no controls.
SX402-11	None	Worker safety concerns related to spiders, snakes, rodents, and bio hazards	Worker comes into contact with insects, snakes, rodents, or bio hazards	None	None	None	AC: Safety Management Programs	Controls based on AC 5.24, Safety Management Programs (Occupational Health and Safety). Safety Management Programs control facility worker exposure to workplace hazards.	These agents are always present on the Hanford Site. Captured for completeness only.

*HNF-SD-WM-SAR-067, 2000, *Tank Waste Remediation System Final Safety Analysis Report*, revision as amended, CH2M HILL Hanford Group, Inc., Richland, Washington.

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APPENDIX C

TECHNICAL PEER REVIEW

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APPENDIX C-1

TECHNICAL PEER REVIEW

CHECKLIST FOR AB DOCUMENT CALCULATION TECHNICAL PEER REVIEW

Document and Section Reviewed: RPP-6637, Rev. 0, "Hazard Evaluation for AX-IX, ITS1, 241-SX-401, 241-SX-402, 241-C-801, 241-A-431"

Scope of Review: The review is limited to the conduct and technical accuracy of the hazard identification and evaluation.

Yes	No	NA	
[X]	[ ]	[ ]	Previous reviews are complete and cover the analysis, up to the scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem is completely defined.
[X]	[ ]	[ ]	Accident scenarios are developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions are explicitly stated and supported.
[ ]	[ ]	[X]	Computer codes and data files are documented.
[ ]	[ ]	[X]	Data used in calculations are explicitly stated.
[ ]	[ ]	[X]	Data were checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations were checked including dimensional consistency of results.
[ ]	[ ]	[X]	Models are appropriate and were used within their established range of validity, or adequate justification was provided for use outside their established range of validity.
[ ]	[ ]	[X]	Spreadsheet results and all hand calculations were verified.
[ ]	[ ]	[X]	Software input is correct and consistent with the document reviewed.
[ ]	[ ]	[X]	Software output is consistent with the input and with the results reported in the document reviewed.
[X]	[ ]	[ ]	Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references.
[ ]	[ ]	[X]	Safety margins are consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions are consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the purpose.

[X] [ ] [ ] **Concurrence**

William H. Grams *W H Grams* — October 20, 2000

Reviewer (Printed Name and Signature) — Date

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APPENDIX C-2

CHECKLIST FOR TECHNICAL PEER REVIEW

Preparation and Review of Calculation Notes	**Manual**	**HNF-2353**
	Desk Instruction	**4.3, Rev. 3**
	Page	**9 of 10**
	Effective Date	**10/29/01**

ATTACHMENT C

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: RPP-6637, "Hazard Evaluation for 241-AX-IX, IT5I, 241-SX-401, 241-SX-402, 241-C-801, 241-A-431." Rev. 1.

Scope of Review (e.g., document section or portion of calculation): Sections 1.0-6.0

Yes	No	NA*	
[X]	[ ]	[ ]	1. Previous reviews are complete and cover the analysis, up to the scope of this review, with no gaps.
[X]	[ ]	[ ]	2. Problem is completely defined.
[X]	[ ]	[ ]	3. Accident scenarios are developed in a clear and logical manner.
[X]	[ ]	[ ]	4. Analytical and technical approaches and results are reasonable and appropriate. *(ORP QAPP criterion 2.8)*
[X]	[ ]	[ ]	5. Necessary assumptions are reasonable, explicitly stated, and supported. *(ORP QAPP criterion 2.2)*
[ ]	[ ]	[X]	6. Computer codes and data files are documented.
[ ]	[ ]	[X]	7. Data used in calculations are explicitly stated.
[ ]	[ ]	[X]	8. Bases for calculations, including assumptions and data, are consistent with the supported safety basis document (e.g., the Tank Farms Final Safety Analysis Report).
[ ]	[ ]	[X]	9. Data were checked for consistency with original source information as applicable. *(ORP QAPP criterion 2.9)*
[X]	[ ]	[ ]	10. For both qualitative and quantitative data, uncertainties are recognized and discussed, as appropriate. *(ORP QAPP criterion 2.17)*
[ ]	[ ]	[X]	11. Mathematical derivations were checked including dimensional consistency of results. *(ORP QAPP criterion 2.16)*
[ ]	[ ]	[X]	12. Models are appropriate and were used within their established range of validity or adequate justification was provided for use outside their established range of validity.
[ ]	[ ]	[X]	13. Spreadsheet results and all hand calculations were verified.
[ ]	[ ]	[X]	14. Calculations are sufficiently detailed such that a technically qualified person can understand the analysis without requiring outside information. *(ORP QAPP criterion 2.5)*
[ ]	[ ]	[X]	15. Software input is correct and consistent with the document reviewed.
[ ]	[ ]	[X]	16. Software output is consistent with the input and with the results reported in the document reviewed.
[ ]	[ ]	[X]	17. Software verification and validation are addressed adequately. *(ORP QAPP criterion 2.6)*
[X]	[ ]	[ ]	18. Limits/criteria/guidelines applied to the analysis results are appropriate and referenced. Limits/criteria/guidelines were checked against references. *(ORP QAPP criterion 2.9)*
[X]	[ ]	[ ]	19. Safety margins are consistent with good engineering practices.
[X]	[ ]	[ ]	20. Conclusions are consistent with analytical results and applicable limits.

Preparation and Review of Calculation Notes	**Manual**	**HNF-2353**
	Desk Instruction	**4.3, Rev. 3**
	Page	**10 of 10**
	Effective Date	**10/29/01**

[X] [ ] [ ] 21. Results and conclusions address all points in the purpose. *(ORP QAPP criterion 2.3)*

[ ] [X] [ ] 22. All references cited in the text, figures, and tables are contained in the reference list. one missed ECN-see markup.

[X] [ ] [ ] 23. Reference citations (e.g., title and number) are consistent between the text callout and the reference list.

[X] [ ] [ ] 24. Only released (i.e., not draft) references are cited. *(ORP QAPP criterion 2.1)*

[X] [ ] [ ] 25. Referenced documents are retrievable or otherwise available.

[X] [ ] [ ] 26. The most recent version of each reference is cited, as appropriate. *(ORP QAPP criterion 2.1)*

[X] [ ] [ ] 27. There are no duplicate citations in the reference list.

[X] [ ] [ ] 28. Referenced documents are spelled out (title and number) the first time they are cited.

[X] [ ] [ ] 29. All acronyms are spelled out the first time they are used.

[X] [ ] [ ] 30. The Table of Contents is correct.

[X] [ ] [ ] 31. All figure, table, and section callouts are correct.

[X] [ ] [ ] 32. Unit conversions are correct and consistent.

[X] [ ] [ ] 33. The number of significant digits is appropriate and consistent.

[ ] [ ] [X] 34. Chemical reactions are correct and balanced.

[X] [ ] [ ] 35. All tables are formatted consistently and are free of blank cells.

[X] [ ] [ ] 36. The document is complete (pages, attachments, and appendices) and in the proper order.

[X] [ ] [ ] 37. The document is free of typographical errors. Except as noted in markup.

[X] [ ] [ ] 38. The tables are internally consistent.

[ ] [ ] [X] 39. The document was prepared in accordance with HNF-2353, Section 4.3, Attachment B, "Calculation Note Format and Preparation Instructions". Not a Calc. Note.

[ ] [ ] [ ] **Concurrence**

D.M. Carson [signature] 28Jan02

Reviewer (Printed Name and Signature) Date

* If No or NA is chosen, an explanation must be provided on this form.

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